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Power

the magazine of energy systems engineering

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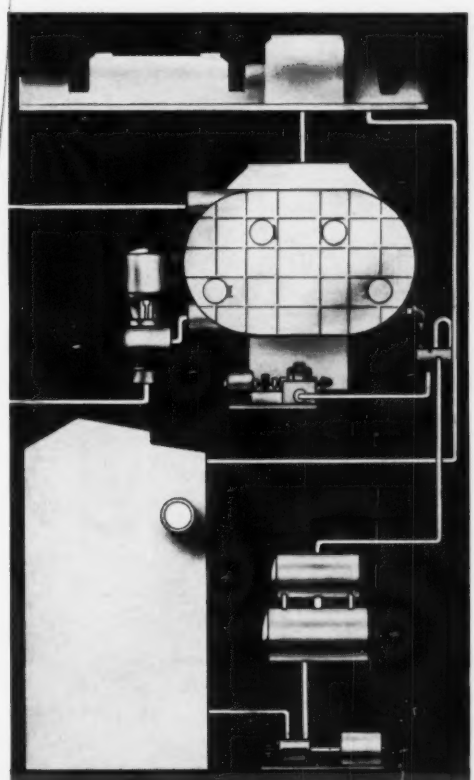

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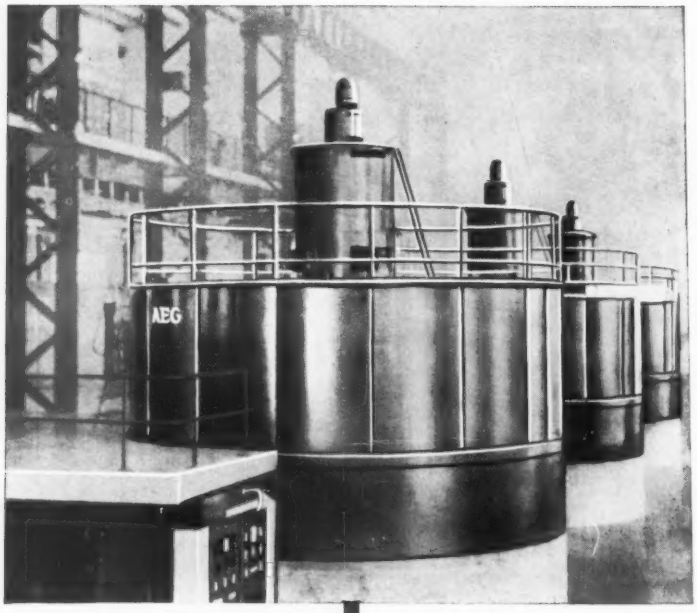

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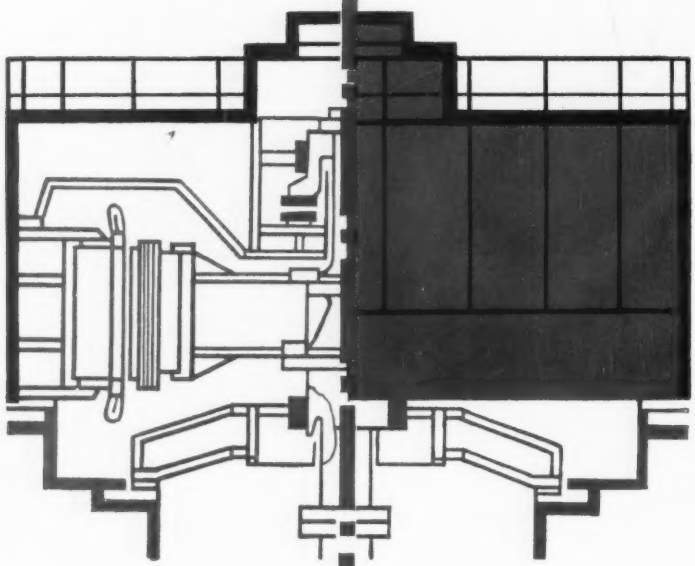

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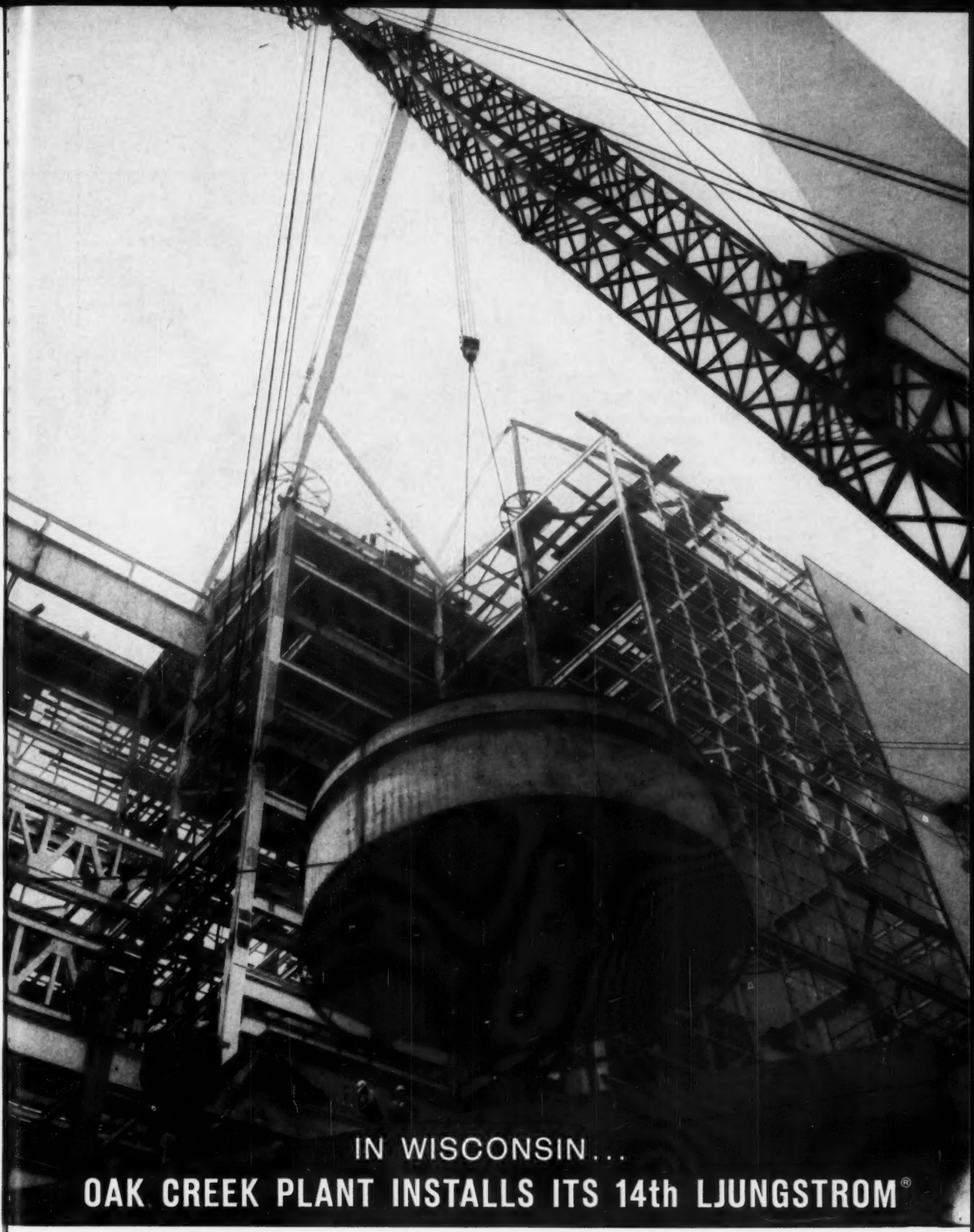

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speaking of **Power**

Four years ago this month, 38 of industry's top executives gathered in Washington to consider what has been done, what is being done, what should be done to insure continuity of their production, management and supply in event of enemy attack. It proved a realistic businesslike facing of facts. One of the areas probed was the extent to which the companies represented at the meeting used protective construction to safeguard their facilities against nuclear attack and consequent fallout.

One company found dispersion of plant facilities less costly and, in their estimation, more effective than protective construction. Another organization was drilling wells and installing pumps to provide for washing roof and walls of its alternate headquarters building. In all, five companies of those at the meeting used some form of protective construction, ten did not, two were considering.

Of late it has become increasingly popular on many fronts to give H-bomb warfare an "unthinkable" classification since, according to some, the result would be mutual annihilation. This kind of thinking—or lack of thinking—leads many to believe we have an automatic deterrent to hold our enemies in check. In this mental climate there is little use in preparing for a nuclear-bomb attack: if deterrence fails, all is lost.

This fuzzy analysis is being attacked on many fronts today. Example: The consulting firm of Burns and Roe have recently completed a study of practical protective measures utility groups can and should take. For that story turn to p 76.

Staffer Ted Edwards, who joined POWER in August 1959 after serving as manager of Worthington's boiler-feed pump section, has been promoted to associate editor. You will recall Ted's recent *TD* reports on hyperbolic cooling towers and condensate scavenging and the special report *Piping* in the June 1960 issue. Edwards will continue his responsibility for the broad field of fluid handling.

Lou Lowley

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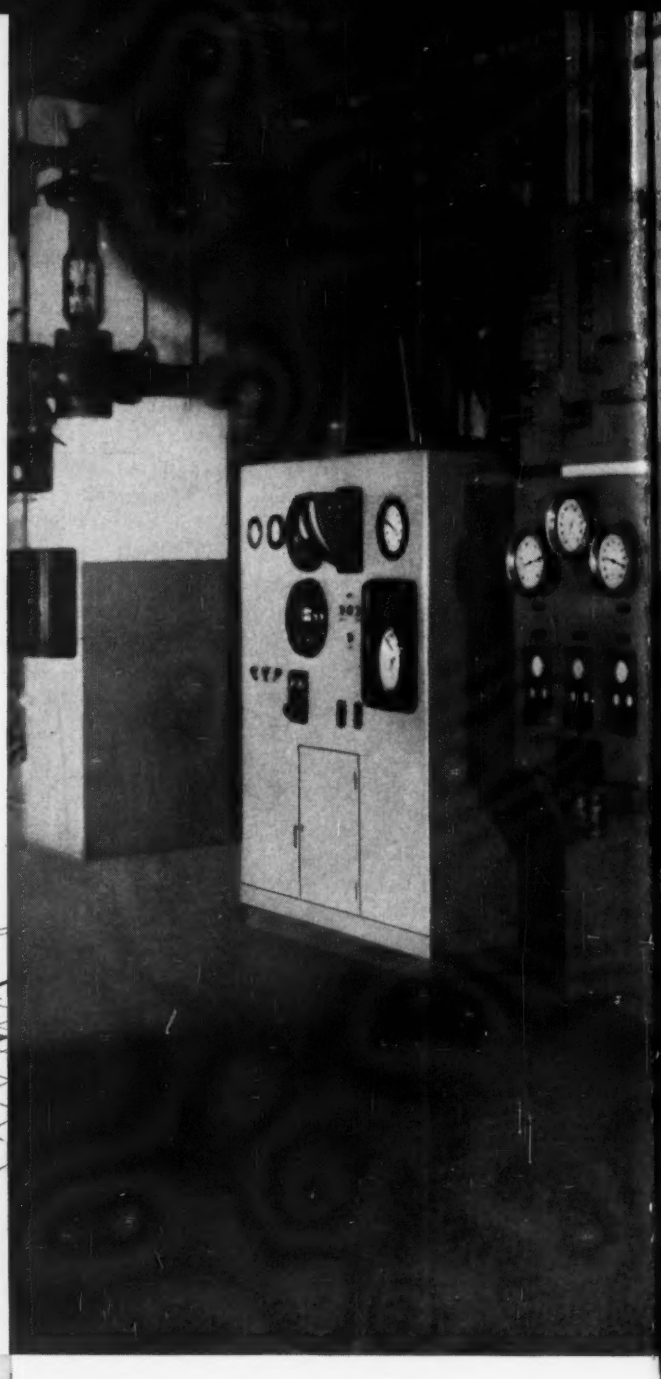
New B&W Boilers Cut Heating Costs 22% for Country's 3rd Largest Building



American Furniture Mart Corporation replaces 3 previous boilers with 2 B&W package units . . . Heats 29 Million cubic feet at fuel cost saving of 22%

The American Furniture Mart dominating Chicago's skyline with a 17 story building topped by a 33 story tower . . . has 29 million cubic feet of space to be heated. It is the largest commercial building in the world devoted to a single industry, home furnishings. Throughout the year, it is the national purchasing center for thousands of retail stores, large and small, and at peak markets, upwards of 45,000 buyers and sellers shop its display spaces. The recent installation of two B&W boilers . . . in place of three previous units . . . provides all the steam necessary for this large heating job at a fuel cost saving of 22%. Additional economies can be realized because fuels can be switched in a matter of minutes

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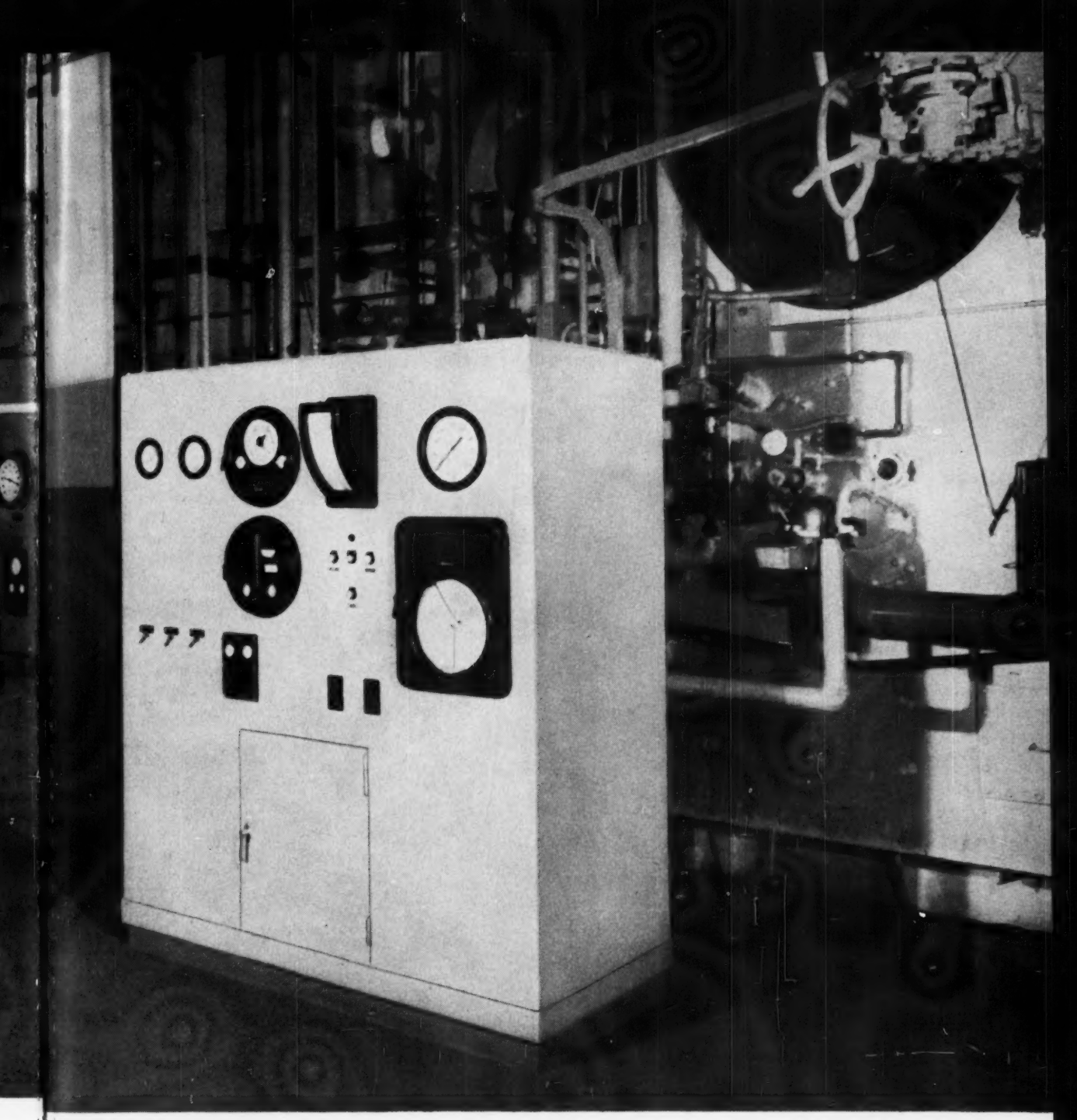

use the fuel most economical at any given time. Moreover, se new boilers are fast steaming . . . put out plenty of heat a hurry even after being turned off all night.

addition to cutting fuel costs, a savings that will pay for units in five years, these B&W package boilers cut space uirements in half and require fewer men to keep them in ration. It is interesting to note, too, that these boilers re installed during the height of the heating season . . . h minimum loss of heat to the building's occupants dur- the changeover period. Furthermore, management knows t any time in the life of the boiler — 10, 20 or 30 years hence — B&W's nation-wide service organization will be promptly and economically available if needed.

Providing the efficiency, economy, and service necessary to heat the country's third largest building economically is further evidence-in-action of dependable steam generation by B&W. Whatever your steam requirement . . . whatever your most economical fuel . . . B&W has the boiler best suited to your heating application. For information, contact your local B&W representative. He has all the facts on your area. The Babcock & Wilcox Company, Boiler Division, Barberton, Ohio.

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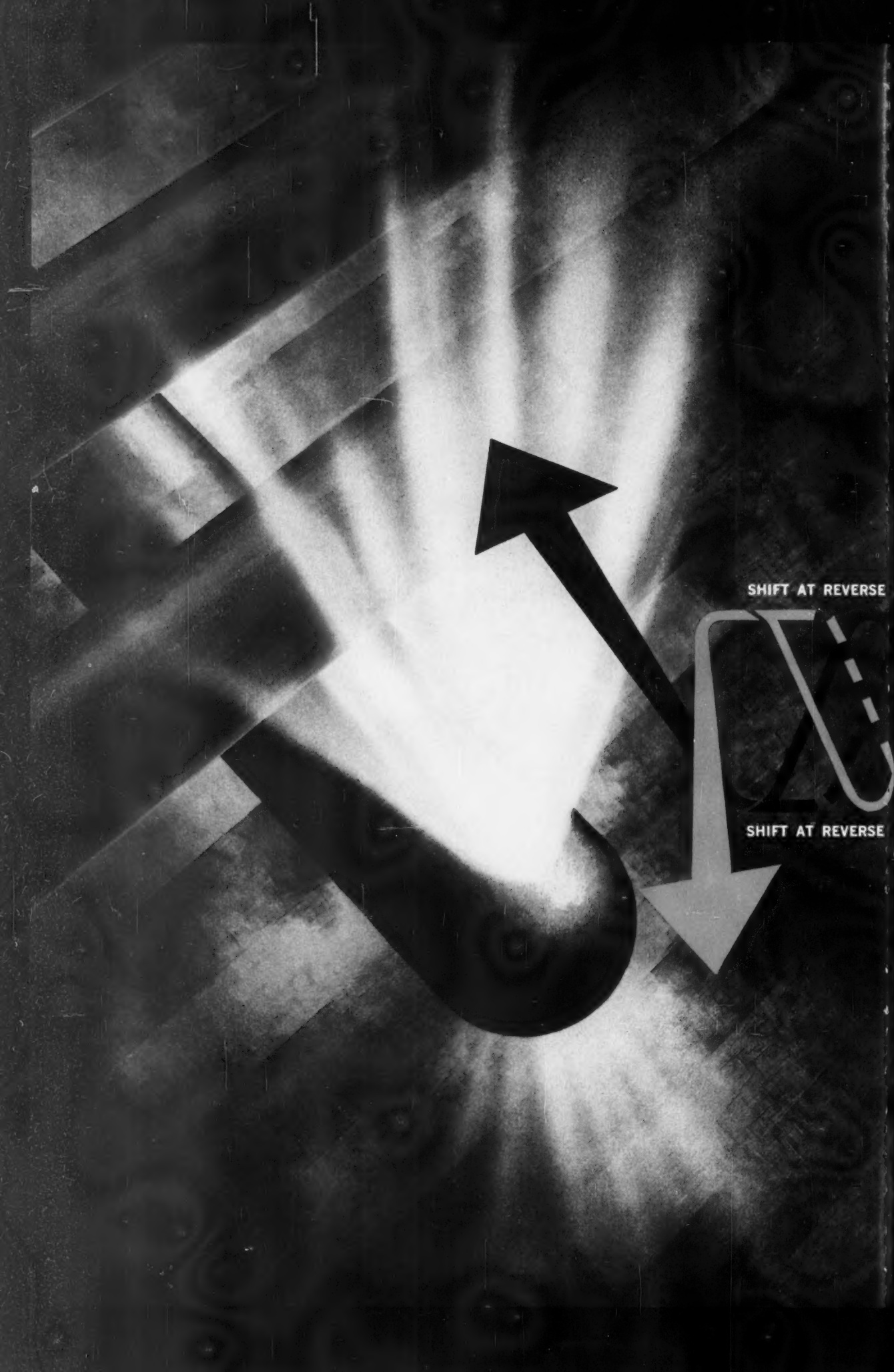
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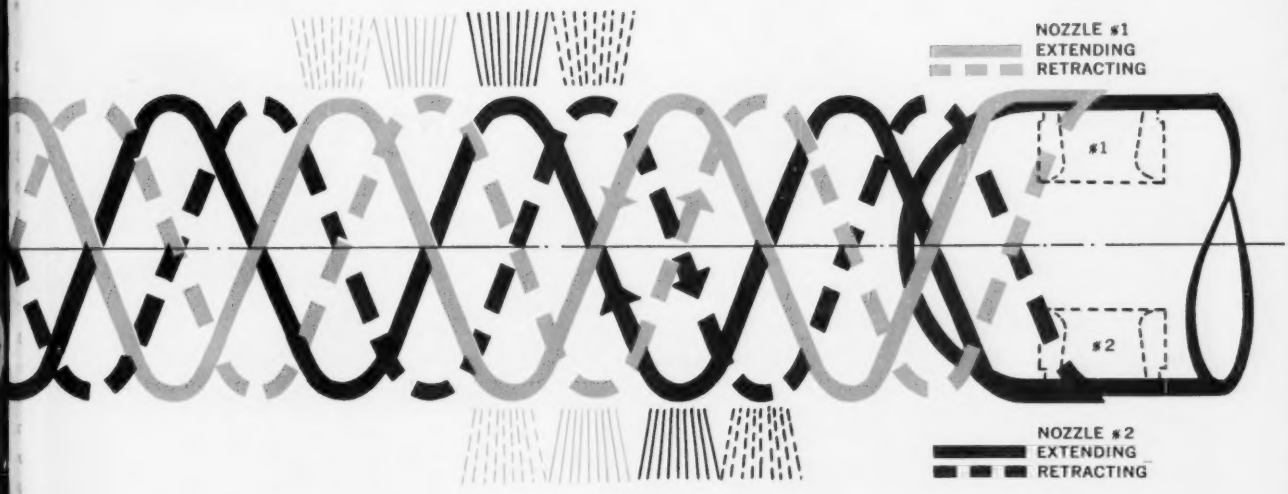

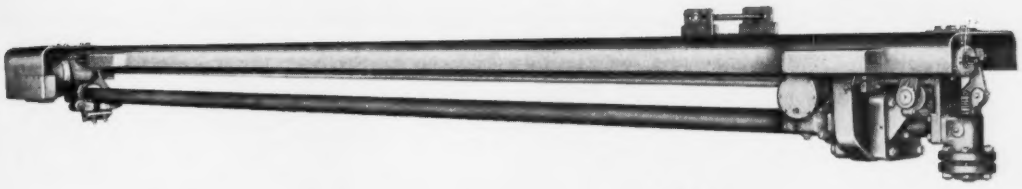

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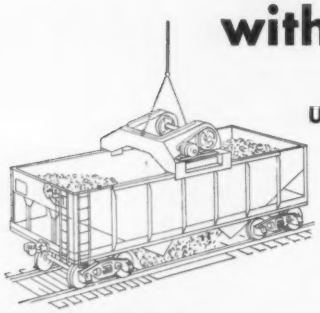

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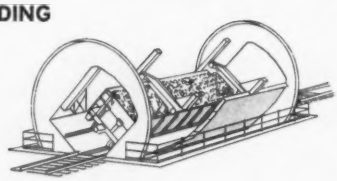

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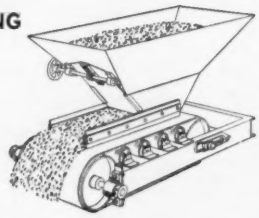

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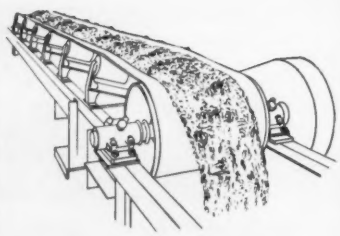

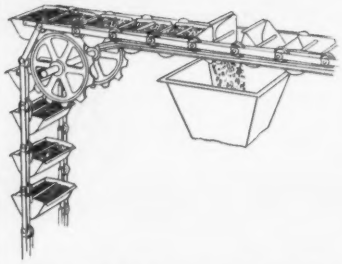

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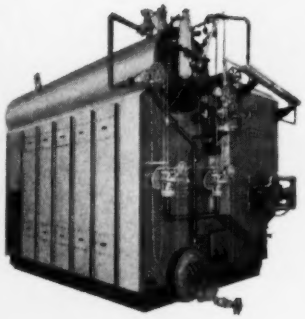

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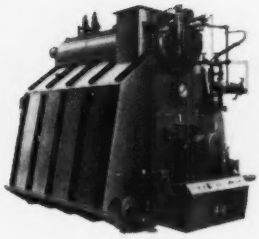

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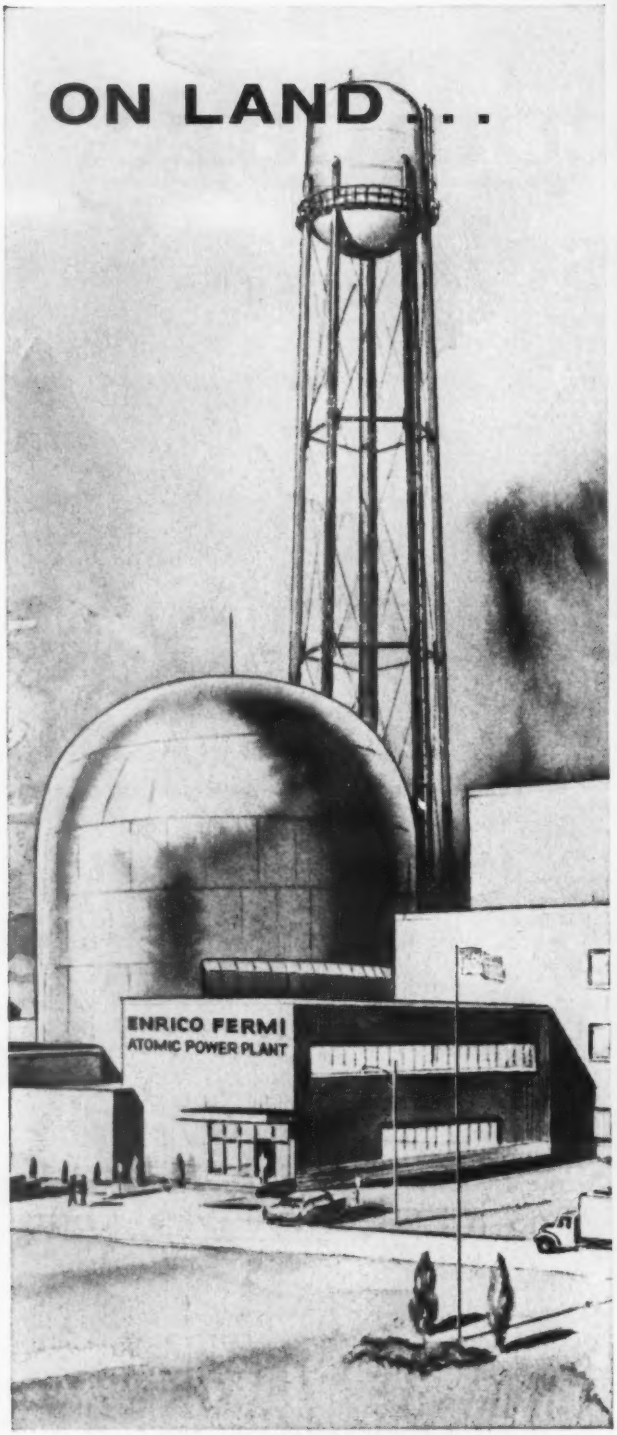

At the Enrico Fermi Atomic Power Plant, instruments and controls for both the "fast neutron breeder" reactor and the steam plant which it will "fire" are being furnished by Bailey.

Many of the new ships such as this super-carrier, USS Ranger, operate their boilers by Bailey Meter Control. Cargo ships, tankers, and passenger liners as well as Naval ships improve the economy and safety of their steam plants thru use of Bailey controls.

At the Thomas H. Allen Electric Generating Station of the City of Memphis, Tenn., Bailey operating indicators and controls for combustion, feed water, and steam temperature are centralized on the mechanical bench-board directly ahead, while the operating records which reflect trends are mounted on the vertical boards. A Bailey METROTYPE Information System, center left in the photo, scans, monitors, and logs functions usually assigned to strip-chart recorders.

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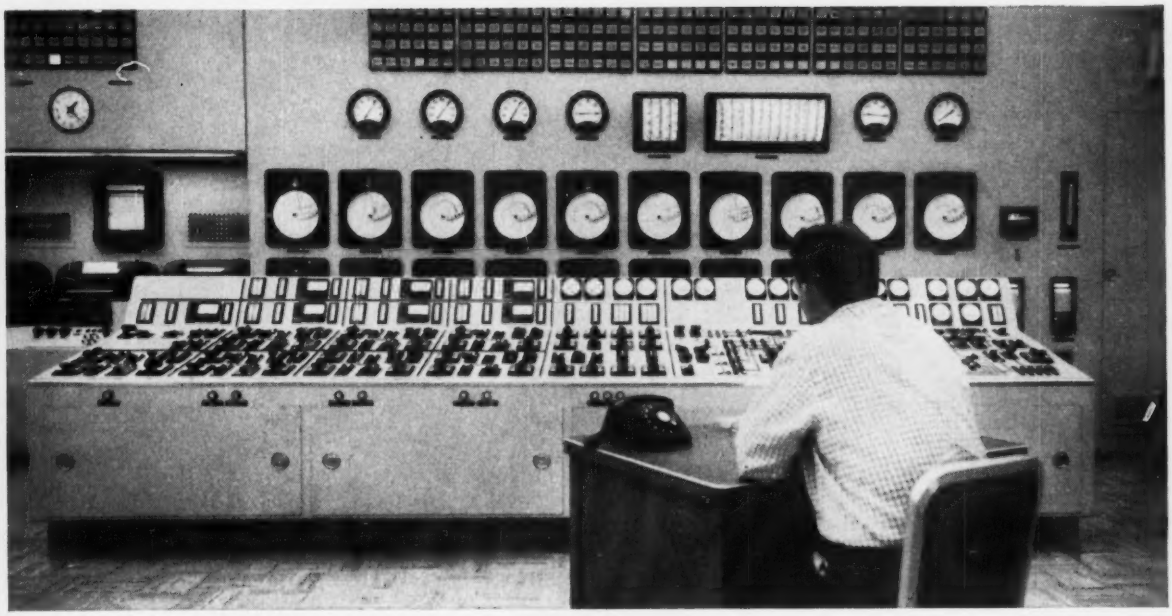

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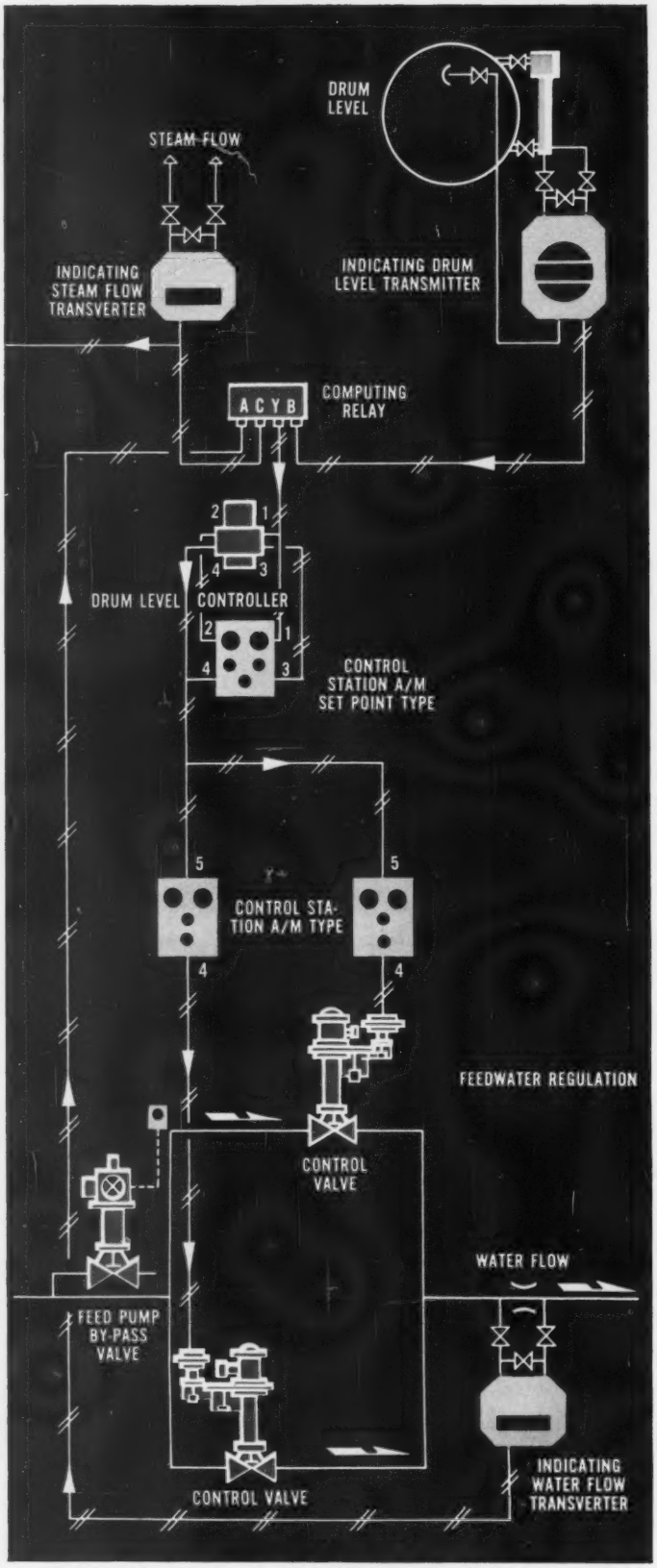
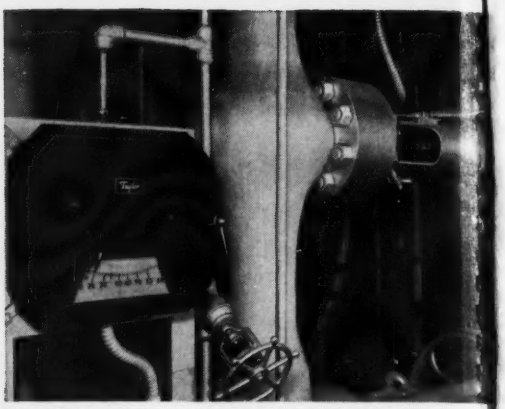
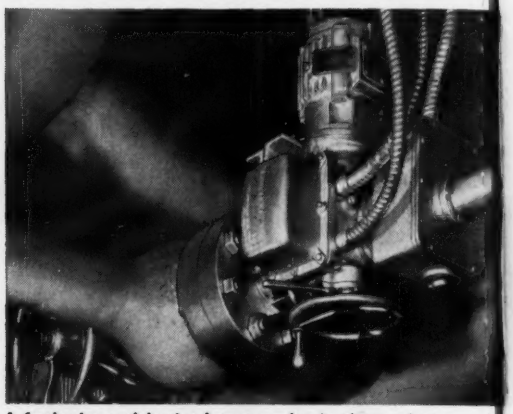


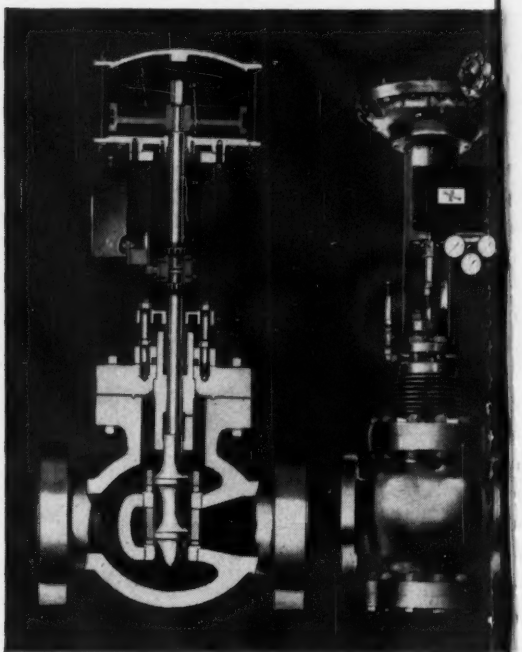
Three influence feedwater regulation is just part of a complete Copes-Vulcan boiler control system installed at a pace-setting utility station. Feed to boiler is modulated by steam flow, feedwater flow, and drum water level.



Copes-Vulcan recirculation control protects boiler feed pumps. When pump discharge falls below a certain level, a diaphragm-operated by-pass valve opens to assure sufficient flow to prevent overheating of the pump.



A feedwater and heater by-pass valve is shown above. Also, a Copes-Vulcan control valve is installed in each of the two main boiler feed lines. These valves handle pressure drops of over 2600 psig without difficulty.



Versatile control valves feature simplicity of design. Piston-type CV-P (left) is ideal for high-duty service. Diaphragm-type CV-D (right) is designed for remote control service. All Copes-Vulcan valves are tailored to the job.

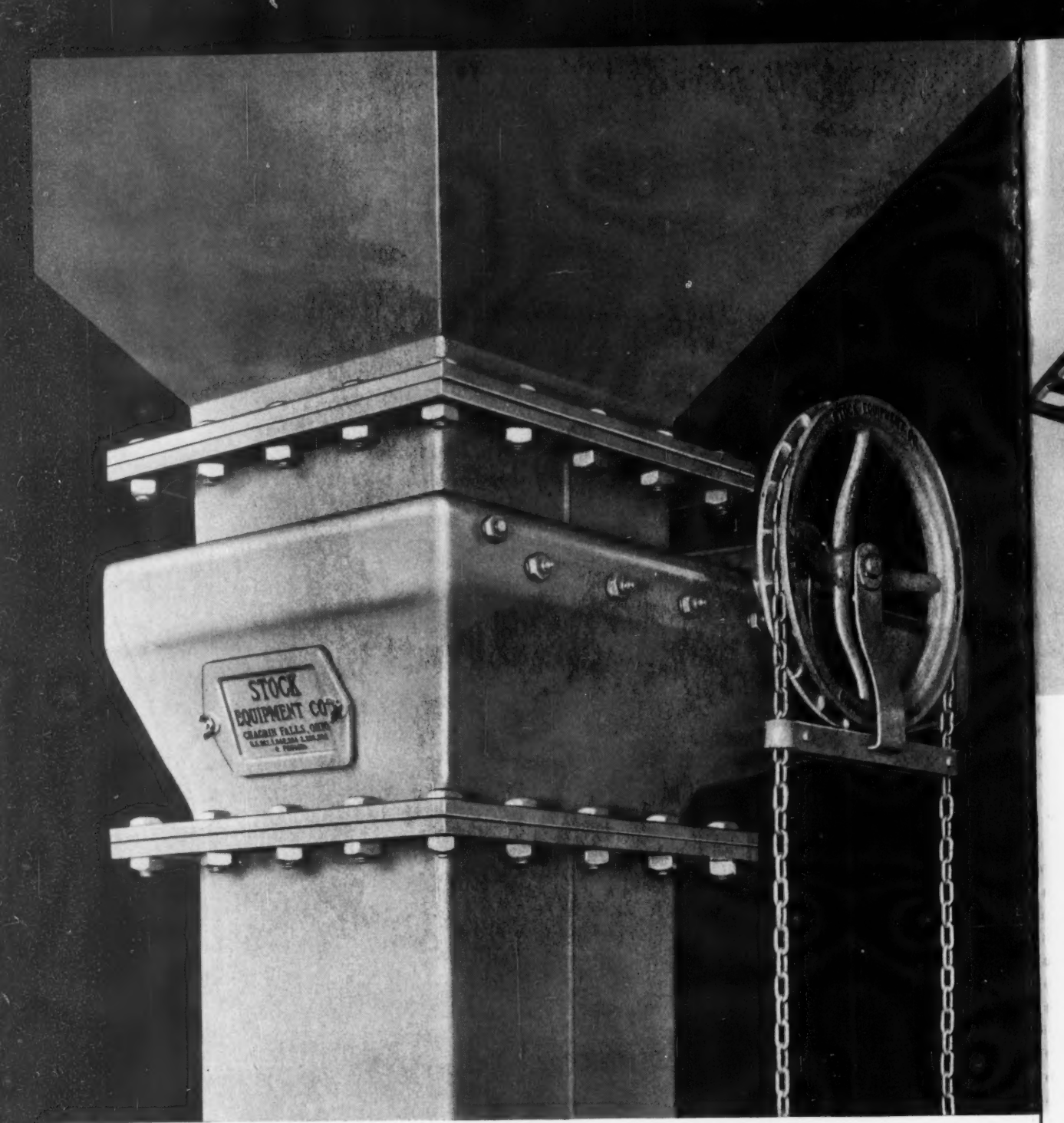
COPES-VULCAN control valves make boiler feedwater systems accurate and trouble-free...

The big load changes of today's boilers put tremendous demands on the accuracy and dependability of feedwater and recirculation systems. Copes-Vulcan systems meet these demands with positive control, positive performance. ■ As long-time specialists in feedwater control, Copes-Vulcan has the experience and design know-how to custom-engineer control valves to rigid specifications. Regardless of high pressure drops, you get close control over full load range, without costly maintenance or replacement. ■ To the dynamic balance of the valves, Copes-Vulcan adds advanced instrumentation. The highly-responsive control system stabilizes water level regardless of changes in load or feed pressure. ■ Bulletin 1038 describes efficient boiler control at a key eastern power station. Write for your copy.
Copes-Vulcan Division, Erie 4, Pennsylvania.

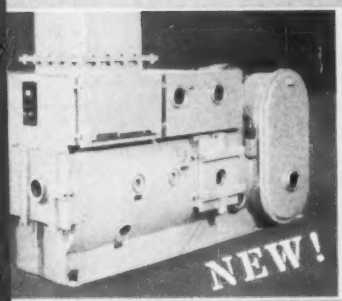
Copes-Vulcan Division
BLAW-KNOX

For more facts circle 210 on Reader Service card, p 103

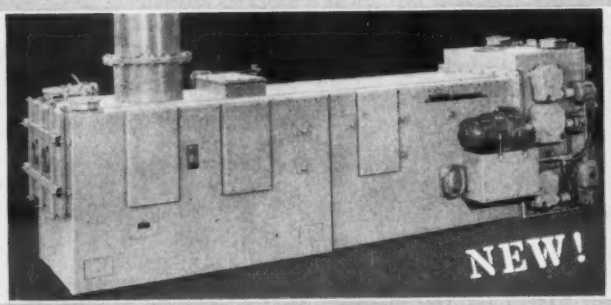
Circle 211 on Reader Service card for following ad ➤



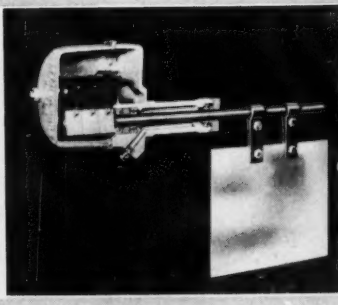
S-E-Co. QUALITY PRODUCTS



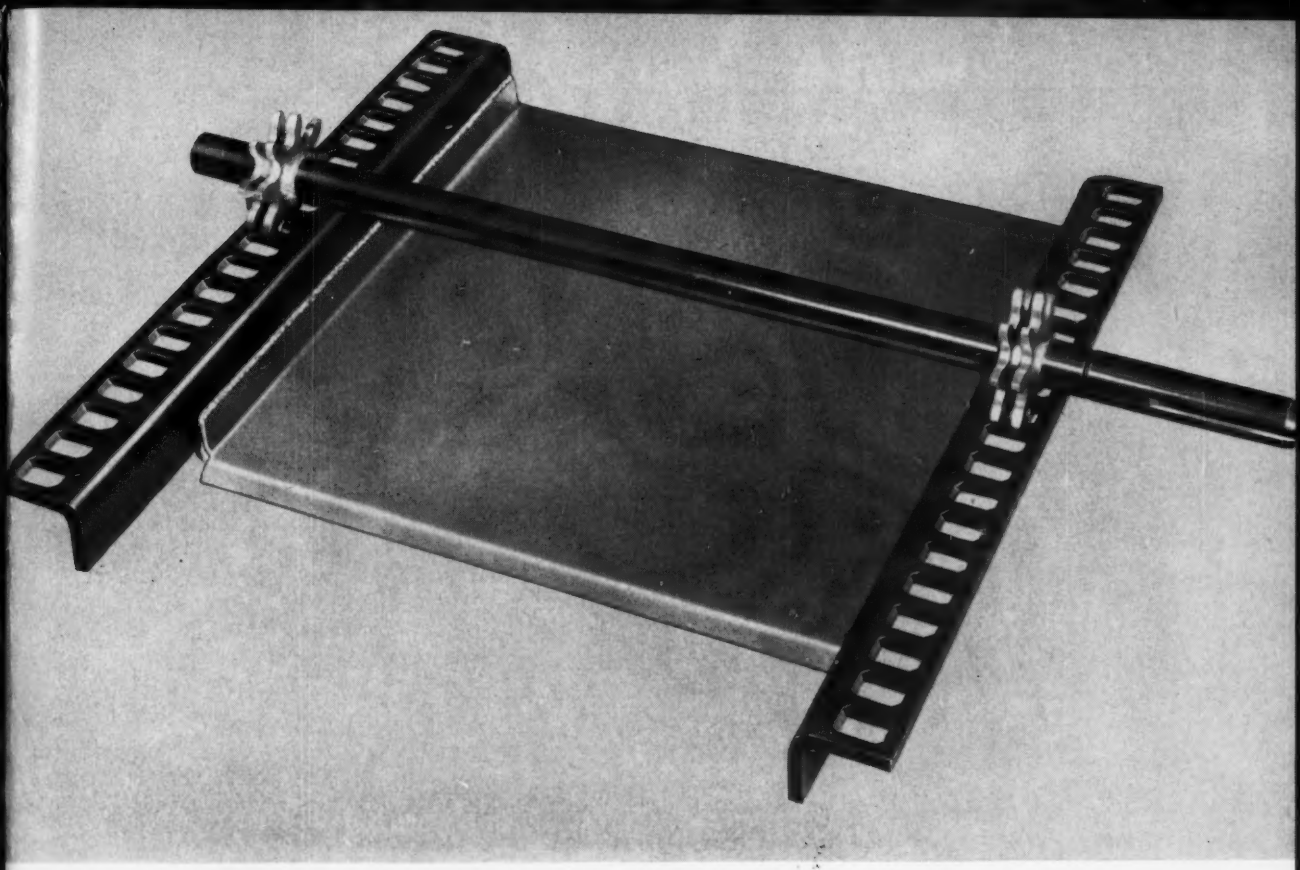
GRAVIMETRIC FEEDERS
Weigh and Feed



VOLUMETRIC FEEDERS
Feed Sticky Coals



STOPPAGE ALARMS
Two Types



Here is Why the S-E-Co. Coal Valve Works

S-E-Co. Coal Valves operate easily under adverse conditions of moisture and corrosive or dusty fuels. Note the U-shaped gate above which incorporates self-cleaning racks along the upper flanged portion of the gate. The self-cleaning pinions are located above the gate to allow a very deep U section, and also to allow dust accumulations to drop through the racks and off of the pinions.

Pinions have multiple faces and a tooth form that provides many times the normal clearance to the sides and back and root of teeth. The ladder racks are cold forged (coined) to exact spacing and tooth shape. This process also gives a dense, harder surface to the rack teeth. The pinions are stainless.

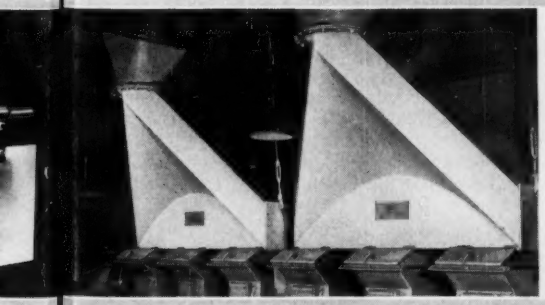
These are only a few of the many reasons why S-E-Co. Coal Valves operate easily and continue to operate easily for many years.

Send your coal valve inquiries to

STOCK EQUIPMENT COMPANY

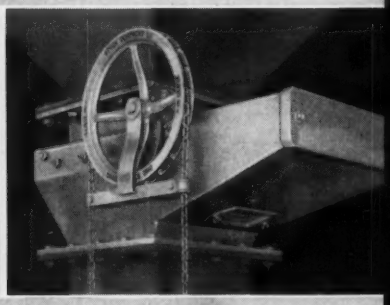
727 HANNA BUILDING • CLEVELAND 15, OHIO

S-E-Co. QUALITY PRODUCTS

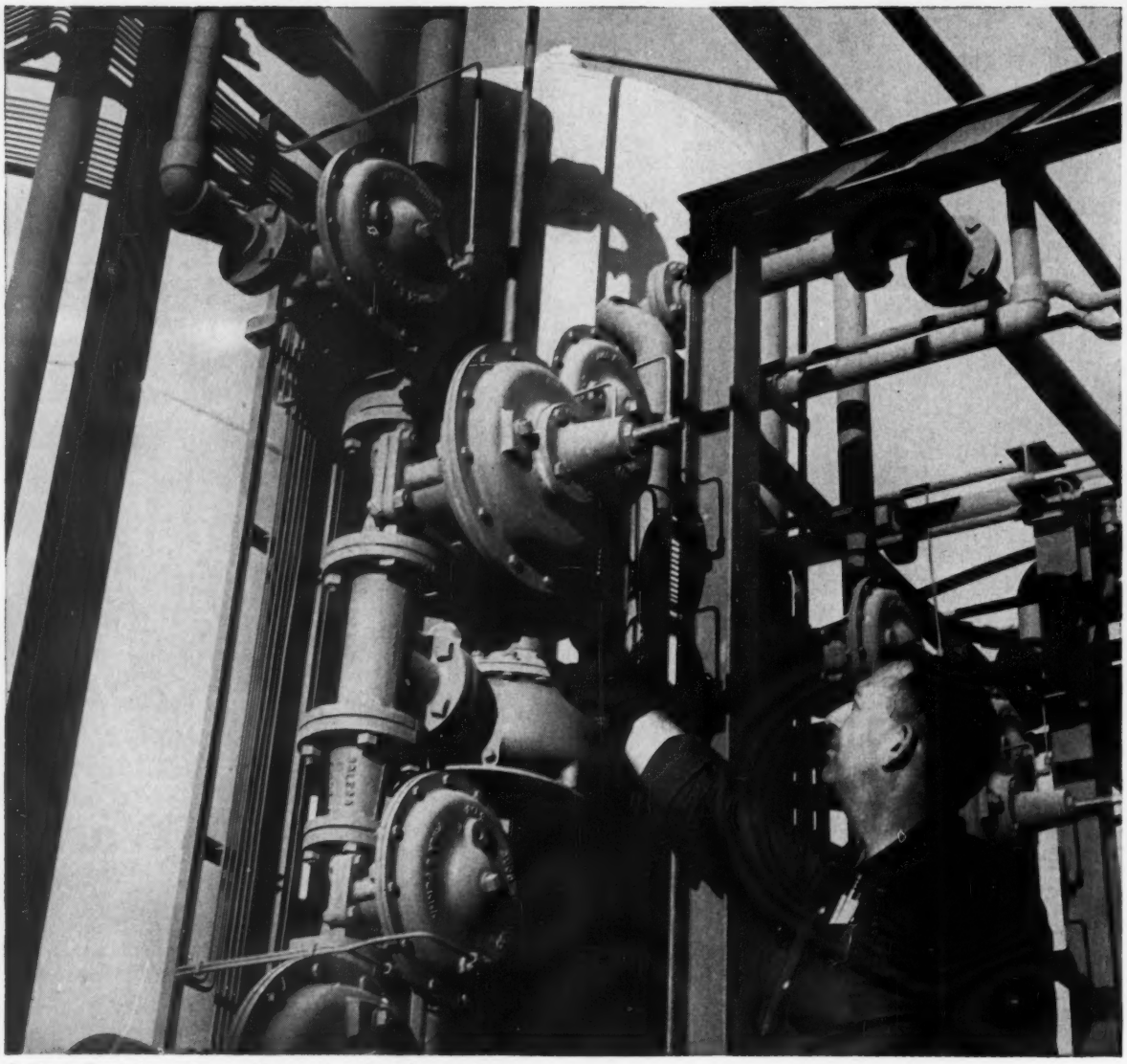


CONICAL NON-SEGREGATING
COAL DISTRIBUTORS

COAL SCALES
Two Basic Sizes



COAL VALVES
6" to 60" — Many Styles



California Electric Power Company's generating station, Yuma, Arizona

SARAN LINED PIPE carries 10,000 gallons per day of "hungry" water to feed high-pressure boiler

At California Electric Power Company's generating station above, a quarter-mile of Saran Lined Pipe feeds highly active deionized water to a high pressure boiler system. This "hungry" water attacks unprotected iron and steel pipe, corroding enough metal to put the boiler and steam turbine out of business and causing such damage to the piping that it must eventually be replaced.

Station Superintendent A. A. Lingo says, "We specified Saran Lined Pipe and valves for this application because, from experience, we knew we could depend on its corrosion resistance. Another important, though not primary, basis for our choice was the reasonable over-all cost of a Saran Lined Pipe installation."

This installation contains nearly 1200 feet of Saran Lined Pipe, 400 feet of it in a vital demineralizing unit. The remainder carries the deionized water to 300,000-gallon storage tanks, and from there to the steam generator. Saran Lined Pipe combines high corrosion resistance and high physical strength. It requires minimum external support on straight runs and little or no maintenance even after years of carrying highly reactive materials.

Saran Lined Pipe, fittings, valves and pumps are available for systems operating from vacuum to 300 psi, from below zero to 200° F. They can be cut, fitted and modified easily in the field without special equipment. For more information, write Saran Lined Pipe Company, 2415 Burdette Avenue, Ferndale, Michigan, Dept. 1569DW2.

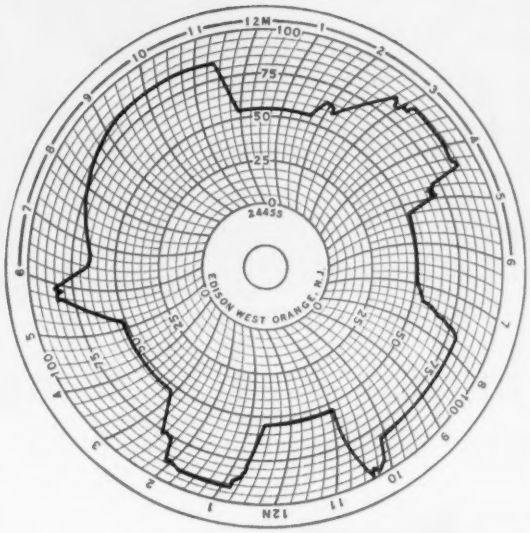
THE DOW CHEMICAL COMPANY DOW Midland, Michigan

For more facts circle 212 on Reader Service card, p 103

NEW FROM EDISON . . .

OMNICORDER

A PRECISE MINIATURE INKLESS RECORDER



- INEXPENSIVE
- RECORDS ANY VARIABLE
- REPLACES METERS OR INDICATORS
- PANEL OR BULKHEAD MOUNTED
- BUILT-IN VARIABLE CHART SPEED
- JUST 3¾″ x 3¾″ x 3″

Now you can take advantage of a new, economical means of recording any variable that can be converted to an electrical signal. Thanks to Omnicorder, you need no longer rely on meters or indicators, even where cost factors or space restrictions would ordinarily dictate the use of these instruments.

Measuring just 3¾″ x 3¾″ x 3″, Edison's Omnicorder, a unique circular chart recorder, is so compact that nine units occupy just one square foot of space. Thoroughly legible, yet requiring no ink, pen or ribbon, Omnicorder is equipped with a simple three-speed adjustment which regulates chart rotation, thereby providing time sequences to meet varied needs. A flick of the switch gives users a choice of these sequences: one hour, seven hours and thirty hours per revolution — or one day, seven days and thirty days per revolution.

Omnicorder's simple, inexpensive construction assures dependable operation and a long, maintenance-free life. Four types of meter movements are available to measure a wide range of AC and DC electrical quantities, ranging from thermocouple outputs to currents as high as 100 amperes. No amplification is ever required, even for signals as low as 10 microamps.

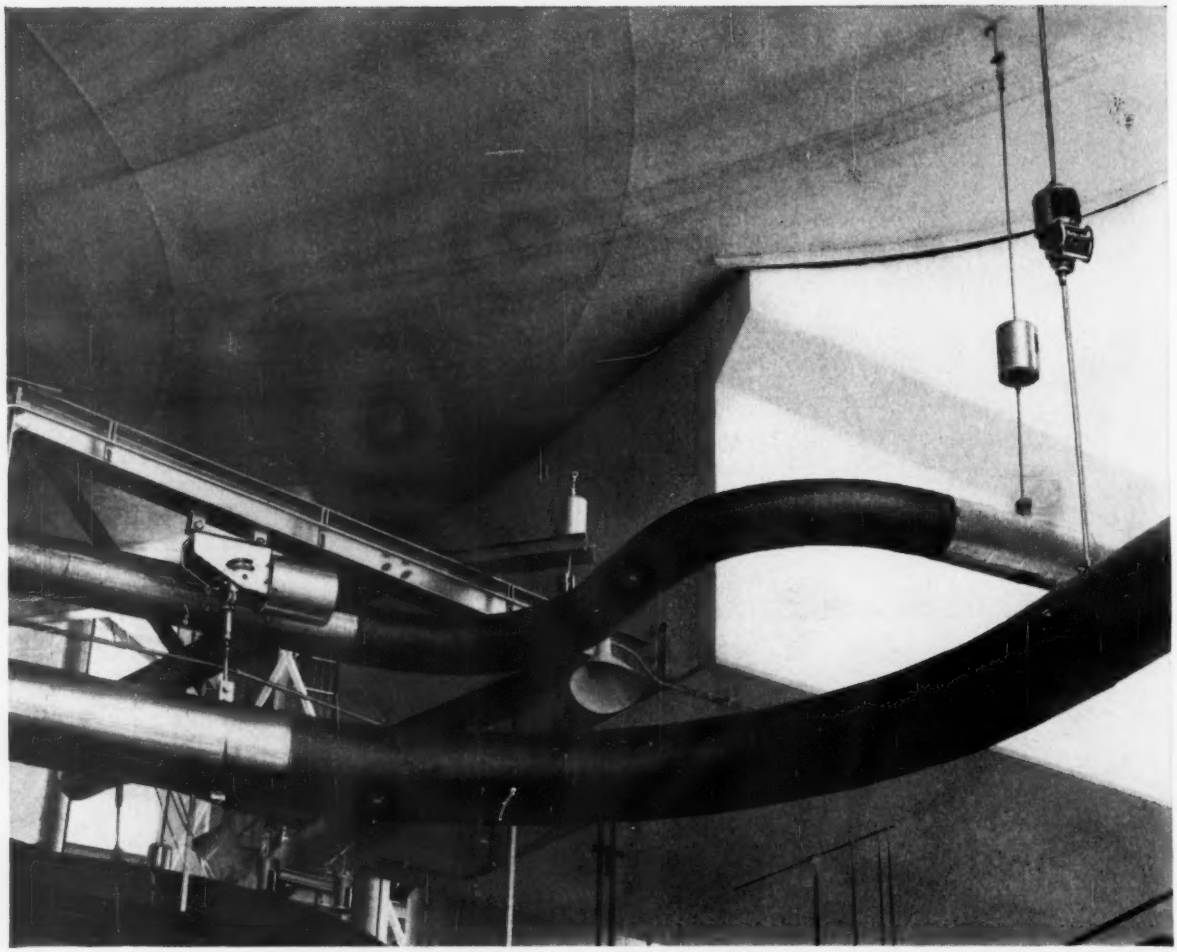
For complete information on this rugged, maintenance-free Omnicorder, write for Catalog 3057.

Stylus operates through this slot. The measuring system is sealed off from any careless tampering.

Zero Set Screw: Adjustment is made when measuring system is not printing and when the circuit to be recorded is disconnected.

Thomas A. Edison Industries
INSTRUMENT DIVISION
43 LAKESIDE AVENUE, WEST ORANGE, N. J.

For more facts circle 213 on Reader Service card, p 103



Grinnell Spring Hangers support the pipes carrying steam from the heat exchangers to the turbines.

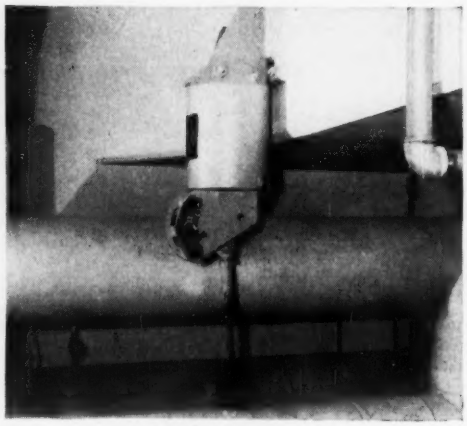
Grinnell Hangers cradle high-pressure piping at new Yankee Atomic Power Plant

At the new Yankee Atomic Power Plant in Rowe, Mass., uranium fuel in the nuclear reactor keeps the water which flows through the reactor at about 500°F. This pressurized water, at 2,000 pounds per square inch pressure, transfers the heat through piping to a steam generator where steam is produced for running power turbines.

Piping that undergoes such high pressures and temperatures must have rugged, *reliable* support. Chosen for this tough job: Grinnell Pipe Hangers!

Grinnell Constant Support Hangers are used where reactive forces at terminal points must be kept within specified limits. Grinnell Variable Spring Hangers are used where piping is subject to vertical movement and does not require a constant support type.

For a complete line of engineered pipe hangers and supports . . . for skilled advice and assistance . . . for experienced field engineering service . . . call on Grinnell Company, Providence 1, Rhode Island.



Turbine extraction lead gets support from Grinnell Constant Support Hanger

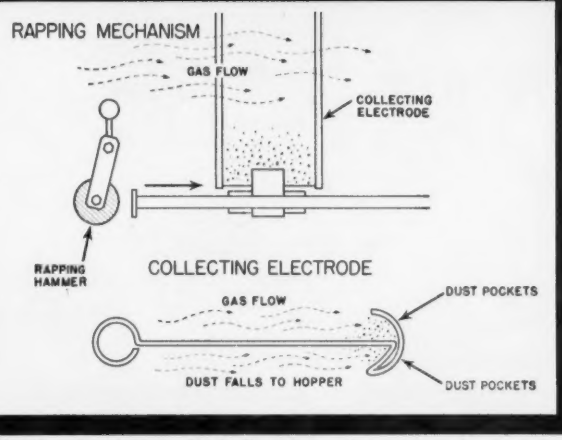
GRINNELL AMERICA'S #1 SUPPLIER OF PIPE HANGERS AND SUPPORTS

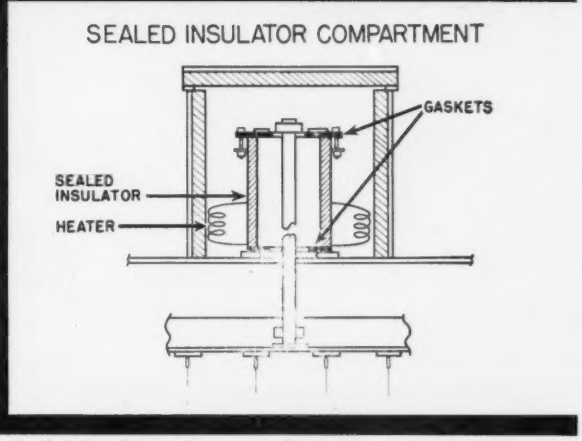
Pipe Fittings, Valves, Pipe Hangers, Prefabricated Piping, Unit Heaters and Piping Specialties • Branch Warehouses and Distributors from Coast to Coast

SOME PLAIN FACTS

ABOUT SUPERIOR PRECIPITATOR PERFORMANCE

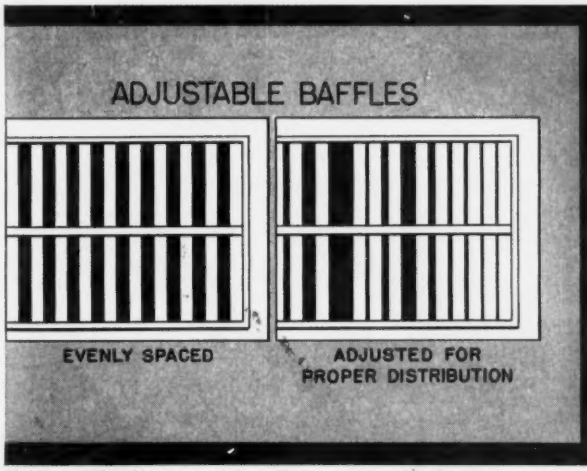
Buell Precipitators are designed and constructed for rugged service and superior performance. Frills and internal frim-fram of a doubtful value are eliminated in favor of strength and simplicity. The casing, outside supports, and internal parts are of rugged construction; and the four-point suspension of emitting electrodes ensures the greatest stability. Here are just a few of the outstanding features of Buell Precipitators.





Effective Continuous Cycle Rapping—Yes, it's mechanical. A simple, rugged system free of complicated gadgets; assures positive dust shearing action. Each row of electrodes is rapped separately—in the direction of the gas flow—on a continuous cycle. Dust is sheared off, drops in an agglomerated mass and pockets on electrodes minimize reentrainment.

Sealed Insulators Improves Operation—High voltage quartz support insulators are completely sealed; prevents gas and dust leaking into insulator compartment and outside air leaking into precipitator. There is no need for costly ventilating systems. Thermostatically controlled electric heaters insure start-up without danger of moisture condensation and insulator breakdown.



Uniform Distribution of Gas Flow—Field adjustment capability is vital. Buell's adjustable baffle permits final positioning after field measurement of actual flow distribution . . . because gas flow patterns are not entirely predictable. The Buell distribution system assures equal gas loading through the precipitator; eliminates ineffective "dead" areas around passages and prevents "sneak-by."

Buell Spiralectrodes cut maintenance to a minimum. Buell's record stands at less than 1% replacement in this key area. Self-tensioned spiralectrodes eliminate vibration and "off-center" swaying, often prevalent with weight-tensioned wires. They're structurally fixed and once installed stay in alignment. The spiralectrode provides greater emission than straight wires.

Buell precipitators are simple and effective. They're designed for continuous service. You'll be glad you turned to Buell when you experience superior performance and low maintenance. Detailed literature describing all features is available.

buell Norblo

The Buell Engineering Co., Inc., Dept. 50-B, 123 William Street, New York 38, N. Y. Northern Blower Division, 6428 Barberton Avenue., Cleveland, Ohio. ■Electric Precipitators ■Cyclones ■Bag Collectors ■Combination Systems ■Fans ■Classifiers.

For more facts circle 215 on Reader Service card, p 103

HERE'S WHY

EASY-GRIP, VENTILATED HANDWHEEL

ACCESSIBILITY—all working parts readily removed through top of yoke. Jack action of stem forces out old packing.

GUIDED VALVE STEM OF #321 STAINLESS STEEL
—will not "pit."
Self-aligning, stellite-faced disc.

HIGH TEMPERATURE INHIBITED STEM PACKING
—furnishes double insurance against packing leaks.

ONE-PIECE FORGED CHROME-MOLY STEEL BODY AND YOKE

EASY FLOW BODY
Smooth inner contours, reduced pressure drop.

UNIQUE SEAT DESIGN
Thermal compensating groove prevents distortion during assembly welding and when welding valve into line, permits perfect seating of disc for positive seal. Integral seat is stellite-faced.

YARWAY WELBONDS® ARE SPECIFIED FOR HIGH PRESSURE/HIGH TEMPERATURE VALVE JOBS

WELBOND VALVES—designed specifically to provide better, longer maintenance-free service in high pressure/high temperature power plants—have won resounding acceptance from operators of modern steam plants everywhere. Welbond performance speaks for itself.

Why do Yarway WELBOND valves give these results? Because only WELBOND combines all these valve advantages:

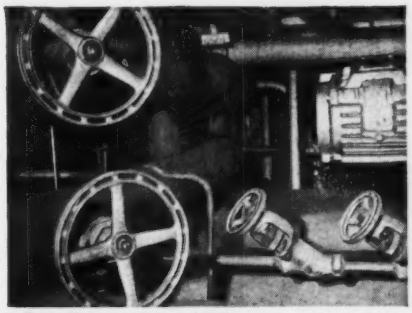
- ✓ Valve stem of 321 austenitic stainless steel prevents pitting. As an added precaution special inhibited packing gives still greater assurance against stem corrosion.
- ✓ Quick *accessibility* of all working parts through top of yoke.
- ✓ Unique seat design with thermal compensating groove provides non-distorting seat, assuring drop tight shut-off. Reseating tools available for quick "on the job" repairs to valve seat.
- ✓ One-piece forged chrome-moly steel body and yoke.
- ✓ Easy-grip, ventilated handwheel.
- ✓ Smooth inner contours, reduced pressure drop.

Yarway WELBOND valves are "proving their mettle" on high pressure boilers in all general services requiring small valves (¼" through 2½").

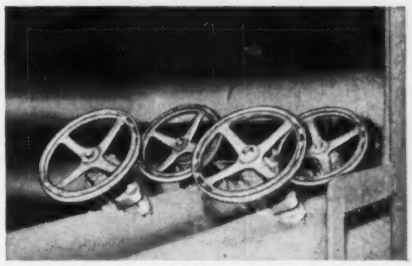
Try WELBONDS in *your* plant. Write for free Yarway Bulletin B-454.

YARNALL-WARING COMPANY
100 Mermaid Ave., Philadelphia 18, Pa.
BRANCH OFFICES IN PRINCIPAL CITIES

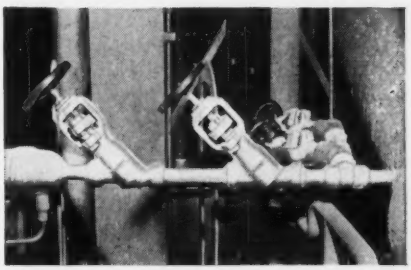
YARWAY
A MARK OF QUALITY IN STEAM ENGINEERING



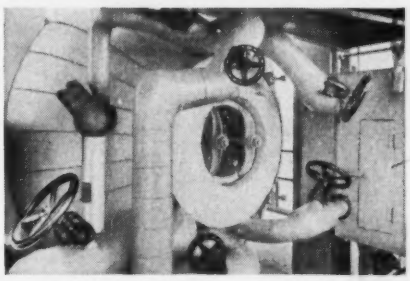
● Four of many Yarway Welbonds installed in large eastern public utility plant. Steam pressure 1850 psi; temperature 1000°F.



● Four of numerous Yarway Welbonds in station of large mid-west utility. These Welbonds installed on header drains.



● Four Yarway Welbonds on main steam line to turbine at southern power plant. Pressure 2310 psi; temperature 1000°F. Over 100 Welbonds in plant.



● Six of more than 900 Yarway Welbonds installed in various power plants of southwest utility. Boiler drum pressure in this plant—2150 psi; superheat temperature 1005°F.

For more facts circle 216 on Reader Service card, p 103

How to inspect electric welded tubing with ultrasonic sound waves

National Tube tests all USS National Electric-Resistance Welded Pressure Tubing with ultrasonic sound waves. As the tubing slides directly over a ground quartz crystal, electrical pulses are focused on the weld area. The crystal changes these pulses into ultrasonic vibrations which bounce off the the weld and reflect its strength or weakness. The vibrations are speared by the crystal, converted back into electrical energy, and floated across an oscilloscope screen.

If a bad weld is reflected, the electrical current dances wildly on the screen and triggers an alarm system. The crooked pattern is pen-recorded on a graph, a frog-voiced horn croaks loudly, and the tubing is squirted with black paint to mark the defect.

In case the ultrasonic unit breaks down, a red-faced dome light automatically flashes, revolves and winks at the weld inspector. This blushing signal tells him that the unit needs to be checked. It's added insurance that every length of pressure tubing is completely tested before it leaves the plant.

Our inspection techniques are rigid. But they help us develop a high quality product for use in applications such as boilers, heat exchangers, condensers, superheaters, economizers and other types of heat transfer equipment.

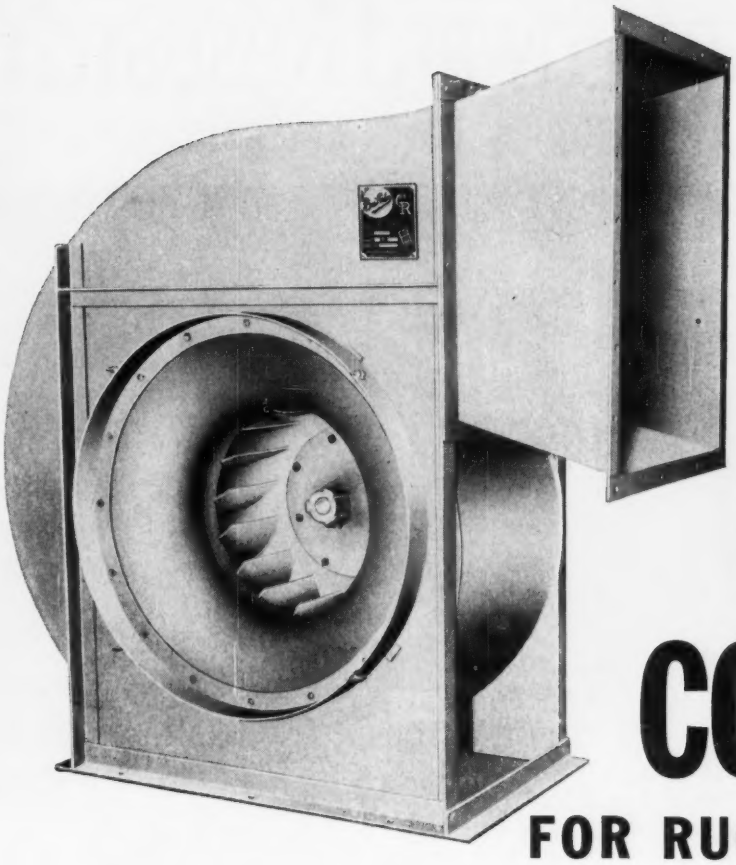
USS National Electric Welded Pressure Tubing is available in sizes ½" O.D. to 5½" O.D. inclusive, in walls from .035" to .250", and in lengths up to 44 feet. Consider USS National Electric Welded Tubing for your next installation. It's stocked by National Tube Distributors all over the country. Our trained Mill Service Force is also available for field consultation. Write National Tube Division, United States Steel, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

USS and National are registered trademarks

National Tube Division of United States Steel

Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors
United States Steel Supply Division
United States Steel Export Company, New York

This mark tells you a product is made of modern, dependable Steel.



THE LOWER-COST FAN

FOR RUGGED SERVICE!

- **for handling heavy dust loadings and abrasive materials.**
- **for induced draft on industrial and power plant service.**
- **choice of three wheels to meet your requirements.**
- **available with inlet vanes or open inlet.**

The 'Buffalo' Type CR Radial Wheel Fan embodies many quality features found only in the finest 'Buffalo' ventilating and draft fans.

Full inlet-to-duct streamlining minimizes abrasive effect and provides stable, efficient performance. The streamlined housing, the curved inlet bell and inlet wheel flange, the smoothly diverging outlet . . . are the same as those in our well-known BLH and airfoil lines. A special tapered inlet box assures smooth entry.

Long-Life CR construction includes heavy-gauge reinforced steel plate housings and inlet boxes with air-tight access doors; heavy-duty self-aligning sleeve or water-cooled bearings; and shafts sized to run well below critical speed and ground to a close fit on the thrust bearing.

A choice of three wheels of varying widths permits exact matching to your pressure-volume requirements with minimum driving horsepower.

For first-cost savings and continued low-cost performance on many severe services, there is no better buy than the 'Buffalo' Type CR Fan. Write for Bulletin FD-205.

"Buffalo"

AIR HANDLING DIVISION

BUFFALO FORGE COMPANY

Buffalo, New York

Buffalo Pumps Division • Buffalo, New York

Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

'Buffalo' Air Handling Equipment to move, heat, cool, dehumidify and clean air and other gases.

'Buffalo' Machine Tools to drill, punch, shear, bend, slit, notch and cope for production or plant maintenance.

'Buffalo' Centrifugal Pumps to handle most liquids and slurries under a variety of conditions.

Squier Machinery to process sugar cane, coffee and rice. Special processing machinery for chemicals.

For more facts circle 218 on Reader Service card, p 103

Circle 219 on Reader Service card for following ad ➤

The Story of Edward Research

and the "Perfect" Globe Valve

Edward designers built the Figure 848 forged steel globe valve from scratch. In an art where most development effort must be directed toward modification, adaptation, and refinement of existing technology, the 848 story is almost unique. The objective was simple: To design and construct a perfect 600-lb-class globe valve in the ¼" to 1" size range. (Basic rating 600 lb at 910 F, 2000 lb WOG.) That the project was virtually successful is a tribute to the ingenuity of the Edward Research Staff and the equipment which enabled them to validate their progress. Here, is that story.

Three areas were given special consideration by the Edward staff of engineers and metallurgists when they set out to design a "perfect" valve. They were: 1. Body Shell and Bonnet Joint; 2. Seat Tightness; 3. Packing Area. Although each area was treated separately, the relationship of one to the other was a factor that had a great deal to do with the outcome of the project.

A series of "torture" tests such as the pressure pulsator shown on the opposite page carried each part and joint to the point of destruction. Thus Edward designers were able to trace each weakness to its source. Perhaps no other valve ever designed has been known and understood so well by the men who designed it.

1. BODY SHELL AND BONNET JOINT. The valve bonnet was bolted finger tight; it tested at 2000 psi. Then, at full design tightness on all four bolts, the bonnet joint did not leak until 11,000 psi (5½ times design pressure!) was applied. Next, 8000 psi applied 100 consecutive times produced no apparent valve damage. Internal pressure was pulsated from 200 to 2000 psi for 10,000,000 cycles with no apparent damage!

The bonnet cap screws were subjected to 350% of design tightness before failure occurred. Further evidence of design effectiveness was the unpredictability of failure. In one case the threads stripped; in another the bolts broke off, and in other there was excessive bending of the bonnet flange. There was no *one* apparent point of weakness!

2. SEAT TIGHTNESS. Similar destructive tests were conducted on the valve stem and seat. The valve required on 65% of standard test closing torque to seal tight at 2000 psi. And 350% of standard torque was built up before the stem sheared below the handwheel. 100 operations at 2½ times standard torque did only negligible damage to seating surfaces. Even after this test only 90% of standard test torque was needed to hold 2000 psi.

3. PACKING AREA. Six times as much load as actually required to seal the packing chamber was applied to the gland bolts without causing damage. A load 3½ times greater than required for sealing was applied 50 times, also without causing damage.

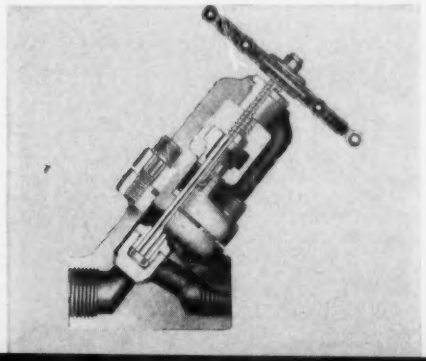
Thus the "perfect" globe valve was designed; perfect not because it can't fail, but perfect because it has no apparent weaknesses. The full design and construction story is told in Edward Catalog 14-G.

Edward builds a complete line of forged and cast steel valves from ¼" to 24" for industrial, marine, petroleum and technological services. For more detailed information, contact your Edward Representative, or write Edward Valves, Inc., 1230 West 145th Street, East Chicago, Indiana. Subsidiary of Rockwell Manufacturing Company. Represented in Canada by Lytle Engineering Specialties, Ltd., 438 St. Peter Street, Montreal.

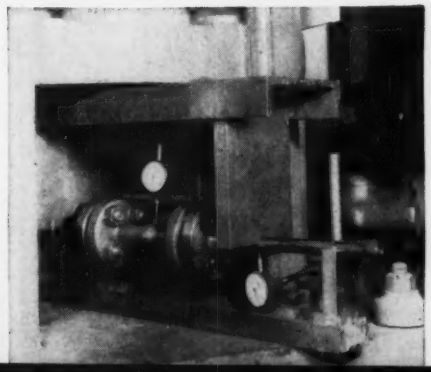
EDWARD STEEL VALVES
another fine product by
ROCKWELL

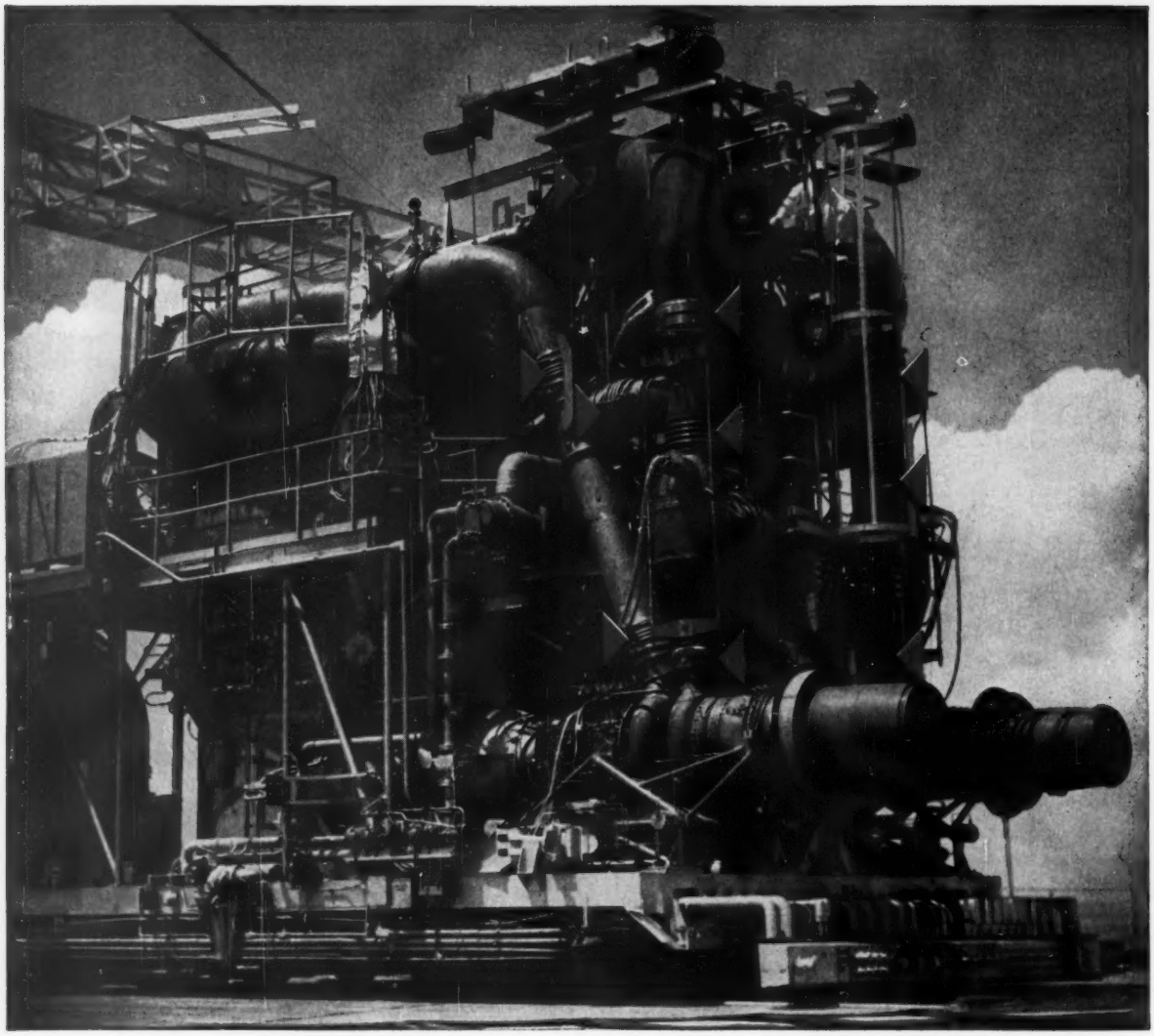
Chief Engineer C.A. Siver and Design Engineer Don Easton observe effects of pulsating pressure on newly designed Figure 848 forged steel globe valve in Rockwell-Edward Research Lab.

Rugged forged steel body . . . combined with high-strength stainless steel gland bolts and bonnet bolts, aluminum-bronze alloy yoke bushing, asbestos-stainless spiral gasket and other premium features . . . makes the Figure 848 a virtually "perfect" small steel valve.



Test arrangement produces uniform bending moment on valve and ½" pipe. Test shows that the strongest pipe likely to be attached to the valve will yield with less than ⅓ the bending moment required to distort body.





Where expansion joint reliability really counts... YOU FIND ZALLEA

Eighteen Zallea Expansion Joints protect all the piping between compressor, reactor and turbine in General Electric's Heat Transfer Reactor Experiment (HTRE). Sizes range from 18-in. to 30-in. diam. Temperatures are 500 F and 1500 F at 53 psig.

Objectives of HTRE were to develop and test a complete aircraft nuclear power plant system, to determine operating characteristics, and to verify the design of a direct-air-cycle nuclear propulsion system. As in any research involving unknown quantities (in this case the heat source) a basic requirement for all system components was *maximum reliability*. The results of HTRE were successful. Objectives were accomplished. The integrity and life of all system components were verified.

This is another example of Zallea competence in the nuclear field. In fact, Zallea has provided the large majority of all the expansion joints used in atomic, nuclear and missile projects. Our work with almost every major engineering and manufacturing firm in these fields has given us an unequalled background of experience and engineering capacity. It can give you important savings in time and investigation when expansion is involved in piping systems or tanks.

Write for Catalog 56, which contains complete and comprehensive engineering data for Expansion Joints from 3-in. to 50-ft. diam., pressures to 3600 psi, temperatures to 1600 F.

ZALLEA BROTHERS, Taylor and Locust Streets, Wilmington 99, Delaware.

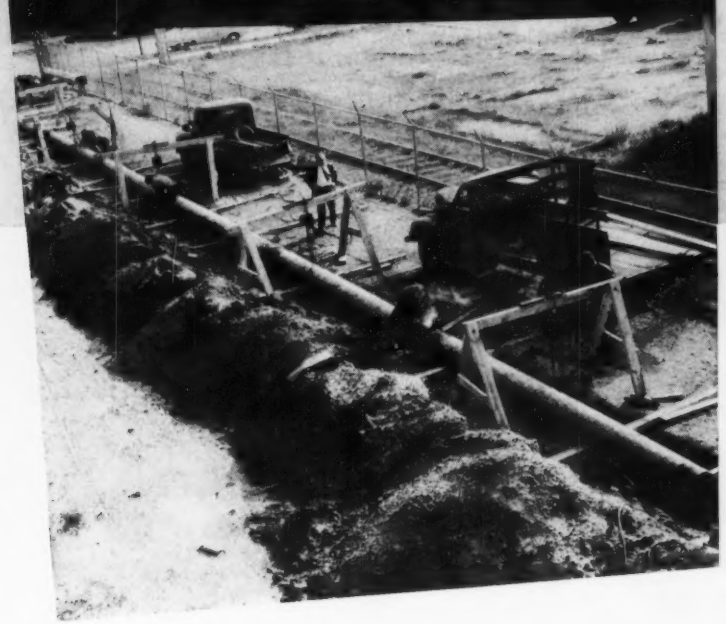
Zallea FOR MAXIMUM RELIABILITY

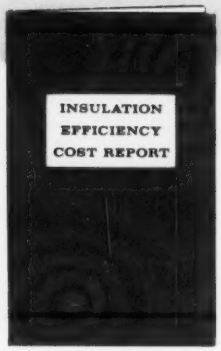
WORLD'S LARGEST MANUFACTURERS OF EXPANSION JOINTS

For more facts circle 220 on Reader Service card, p 103

A 2% HEAT LOSS

can cost YOU $2,000 a month!





Report is based on actual calculations.

The illustrated Insulation Efficiency Report, is a cost comparison study of a Ric-wiL Underground Steam Distribution System vs. a competitive type system. The report is based on actual calculations, using the National District Heating Association's method for determining heat loss. The findings show a 2% heat loss that in one month can cost the owner $2,000.00 in increased steam cost.

The report is yours for the asking . . . and, if you do not already have a Ric-wiL Catalog, ask for a copy along with the report.

Quality Piping Systems . . .
. . . of Exceptionally High Thermal Efficiency

RIC-WIL PREFABRICATED INSULATED PIPING SYSTEMS

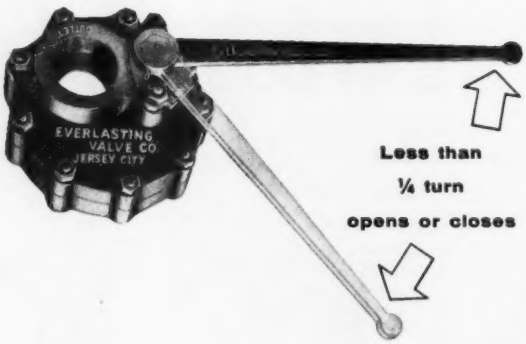
CENTRAL OFFICE: RIC-WIL INCORPORATED, BARBERTON, OHIO
WESTERN STATES: RIC-WIL INCORPORATED, WESTERN DIVISION, NEWARK, CALIFORNIA
IN CANADA: THE RIC-WIL COMPANY OF CANADA LIMITED

For more facts circle 221 on Reader Service card, p 103

WHEN YOU NEED.....

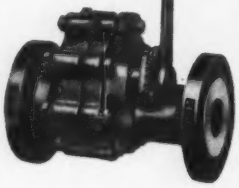
- Quick Action
- Leak-Proof Seal
- Minimum Pressure Drop
- Straight-through full flow
- Valves that cannot wedge or jam
- Self-grinding rotating disc

SPECIFY EVERLASTING VALVES

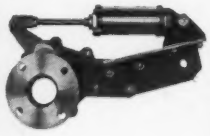


Less than
¼ turn
opens or closes

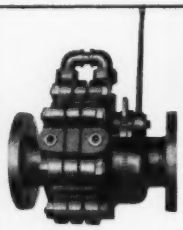
BOILER BLOW-OFF
Quick acting, also handwheel operated "Y" and angle types. For pressures up to 600 psi.



GENERAL SERVICE
Where drop-tight seal and full flow is essential.



CYLINDER OPERATED
Can be remotely controlled, electrically or manually.



STEAM JACKETED
Assures free flow of viscous materials.

WEIGHT-OPERATED
For automatic drains or emergency shut off.

For more information write for these bulletins →

Everlasting VALVES

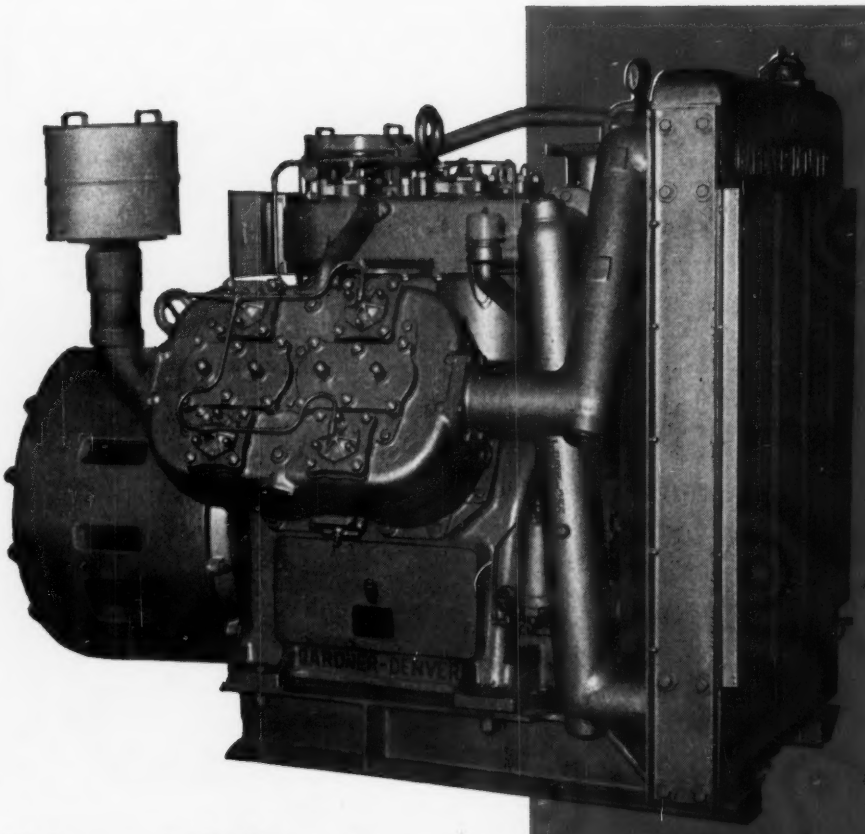
EVERLASTING VALVE CO., FISK STREET, JERSEY CITY 5, N. J.

EV-407

For more facts circle 222 on Reader Service card, p 103

New from Gardner-Denver

Compact compressor for more air on the job



WFO COMPRESSOR FEATURES

- Up to 1395 cfm piston displacement
- 250 hp at 1160 rpm
- 125 psi max. pressure
- Two-stage, water-cooled
- Aluminum pistons for better balance
- New high-speed valves
- V-belt drive, built-in motor or direct-connected motor

Here's a new Gardner-Denver air compressor designed to deliver more air on the job.

This compressor is compact, too. Easy to haul . . . easy to install. Something else: You get the quality engineering you've expected from Gardner-Denver for over 100 years.

For the complete story on this new WFO compressor, see your Gardner-Denver representative or write for Bulletin 1-1v.

EQUIPMENT TODAY FOR THE CHALLENGE OF TOMORROW

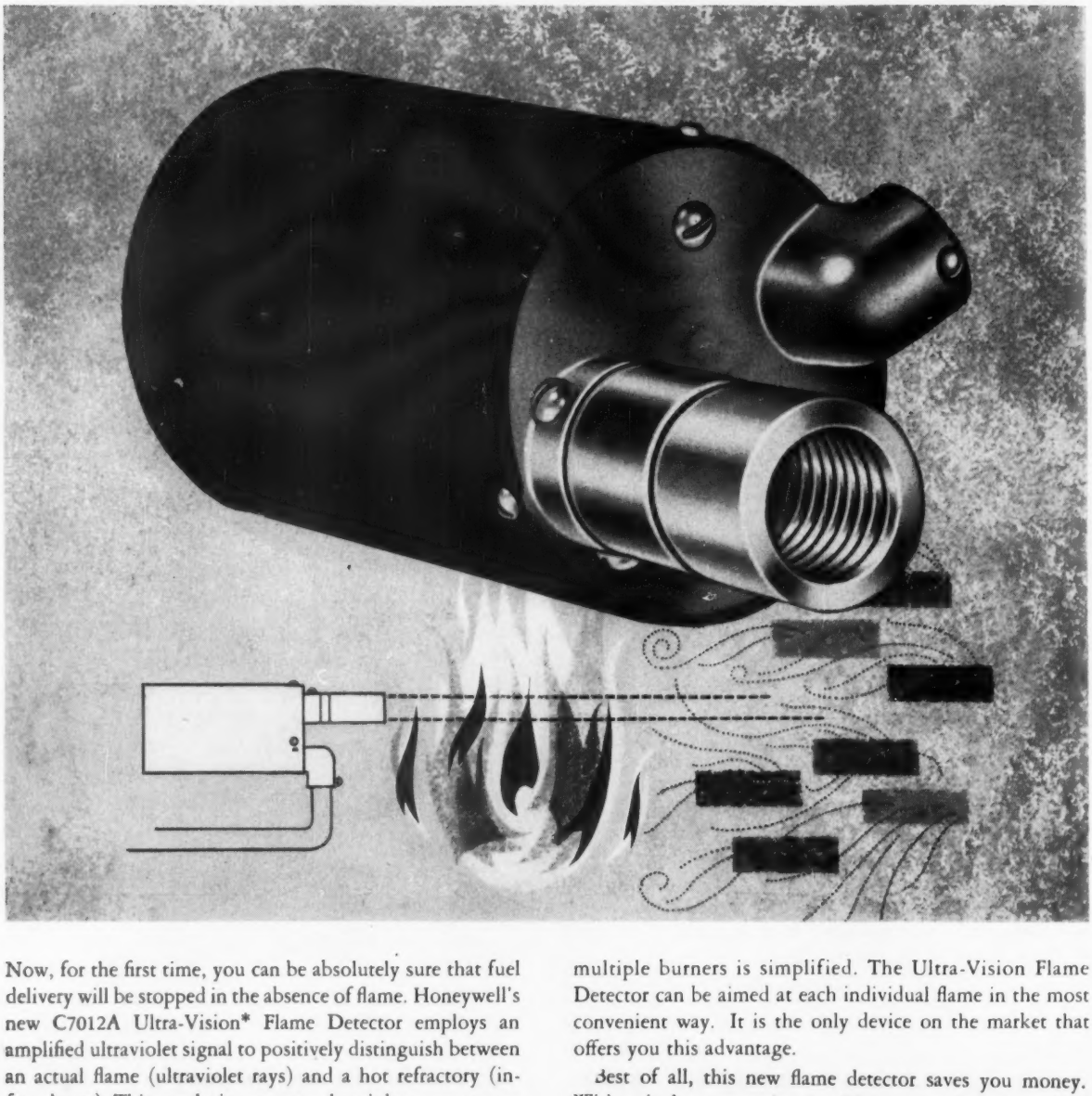
GARDNER - DENVER

Gardner-Denver Company, Quincy, Illinois
In Canada: Gardner-Denver Company (Canada), Ltd., 14 Curity Ave., Toronto 16, Ontario

For more facts circle 223 on Reader Service card, p 103

Undetected flame failure can cause costly interruptions, do serious damage to expensive equipment and endanger lives. To prevent such loss, Honeywell has developed an ultraviolet flame detector that won't be fooled, because it positively differentiates between flame and hot brick.

This flame detector



Now, for the first time, you can be absolutely sure that fuel delivery will be stopped in the absence of flame. Honeywell's new C7012A Ultra-Vision* Flame Detector employs an amplified ultraviolet signal to positively distinguish between an actual flame (ultraviolet rays) and a hot refractory (infrared rays). This revolutionary new ultraviolet sensor represents a major breakthrough in scientific flame detection.

Because this compact new control device is not sensitive to a hot refractory, flame supervision of both single and multiple burners is simplified. The Ultra-Vision Flame Detector can be aimed at each individual flame in the most convenient way. It is the only device on the market that offers you this advantage.

Best of all, this new flame detector saves you money. Wiring is less expensive in this system than in a lead sulphide cell. It is easier to install because hot refractory can be ignored. And there is no further need for flame rod replacement.

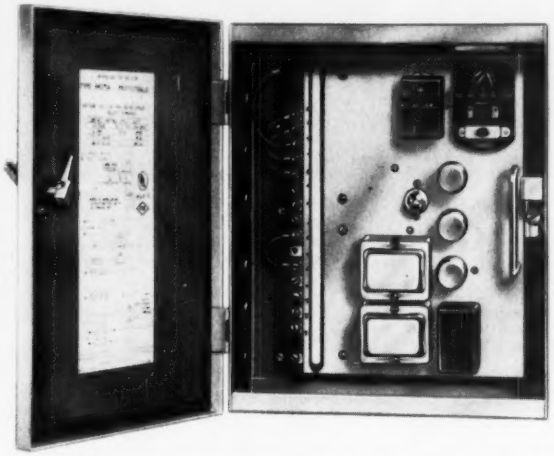
senses only the flame!

New Honeywell Protectoglo relay assures "maximum safety"

Available for use with the Ultra-Vision Flame Detector or with standard flame rods is Honeywell's famous R4075 Protectoglo* relay.

This new relay features "maximum-safety" self-checking which is particularly desirable for continuously burning industrial burners. A self-checking circuit checks the circuit and the components of the Protectoglo *once every second.*

The mounting cabinet of the Protectoglo has all-voltage terminals and a quick-disconnect control base that enables you to remove the relay without disconnecting any of the wiring. Plug-in components can easily be removed and replaced if necessary.



In addition, flame-rod assemblies are available to meet every industrial application. Alarm contacts can be powered from separate line or low-voltage circuit. And a special zinc dichromate finish resists the corrosive effects of most industrial atmospheres.

Trademark

Honeywell protects Los Angeles' new $65,000,000 power plant

Los Angeles' Department of Power and Water installed the Honeywell Ultra-Vision Flame Detector and Protectoglo System to insure maximum flame safeguard protection for its new Scattergood Steam Plant. This huge power facility covers a 57-acre ocean front site south of the Playa del Rey district of Los Angeles.

The plant now uses two 91-foot-long turbine generators to produce 320,000 kilowatts of power. When the entire complement of six generators is put into operation, the anticipated output will be 1,200,000 kilowatts.

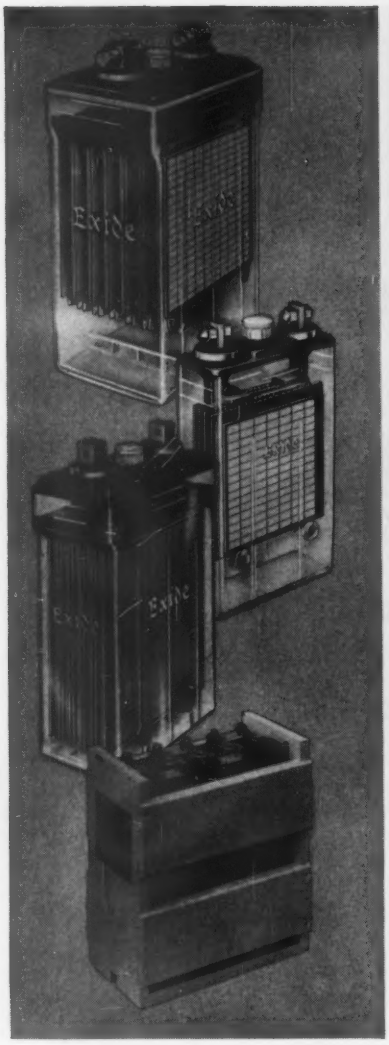
Gas, oil or a combination of both fire the Scattergood boilers. Gas consumption under full load is approximately 1,520,000 cubic feet per hour, and oil is used at 250 barrels an hour. Boilers are 133 feet high and furnace volume is 65,000 cubic feet.

For full information about Honeywell Flame Safeguard Control Systems, call your nearby Honeywell office. Or write Honeywell, Dept. PR-2-23, Minneapolis 8, Minnesota. In Canada, write Honeywell Controls, Limited, Toronto 17, Ontario.

Honeywell

H HONEYWELL *First in Control* SINCE 1885

For more facts circle 224 on Reader Service card, p 103



How to be sure you're right when you buy battery power

First. Make sure your battery is selected on a basis of engineering information. This is how your Exide man makes his recommendation. Because the Exide line includes the broadest range of battery types, he is able to show you factually which particular type is best for you —flat plate Tytex with Silvium* or calcium, long life Exide-Manchex Planté type with Silvium, low maintenance pocket positive nickel-cadmium, or new 20-year Exide-Ironclad tubular with Silvium.

Second. Make sure your charger is engineered to meet the needs of your batteries. Exide chargers come in types and sizes to cover all charging requirements. Correct charging methods prolong battery life and reduce operating and maintenance costs. Choice of either constant voltage, trickle or Hi-Lo type chargers.

Third. Make sure you arrange for service provided by industrial battery specialists. It's included when you get an Exide power package. And it covers both your batteries and chargers. Over 200 Exide factory-trained field men coast to coast are ready to give you fast, competent service. Write for details on the complete Exide power package. Exide Industrial Marketing Division, The Electric Storage Battery Company, Phila. 20, Pa.

*Silvium is Exide's patented corrosion-resistant grid alloy

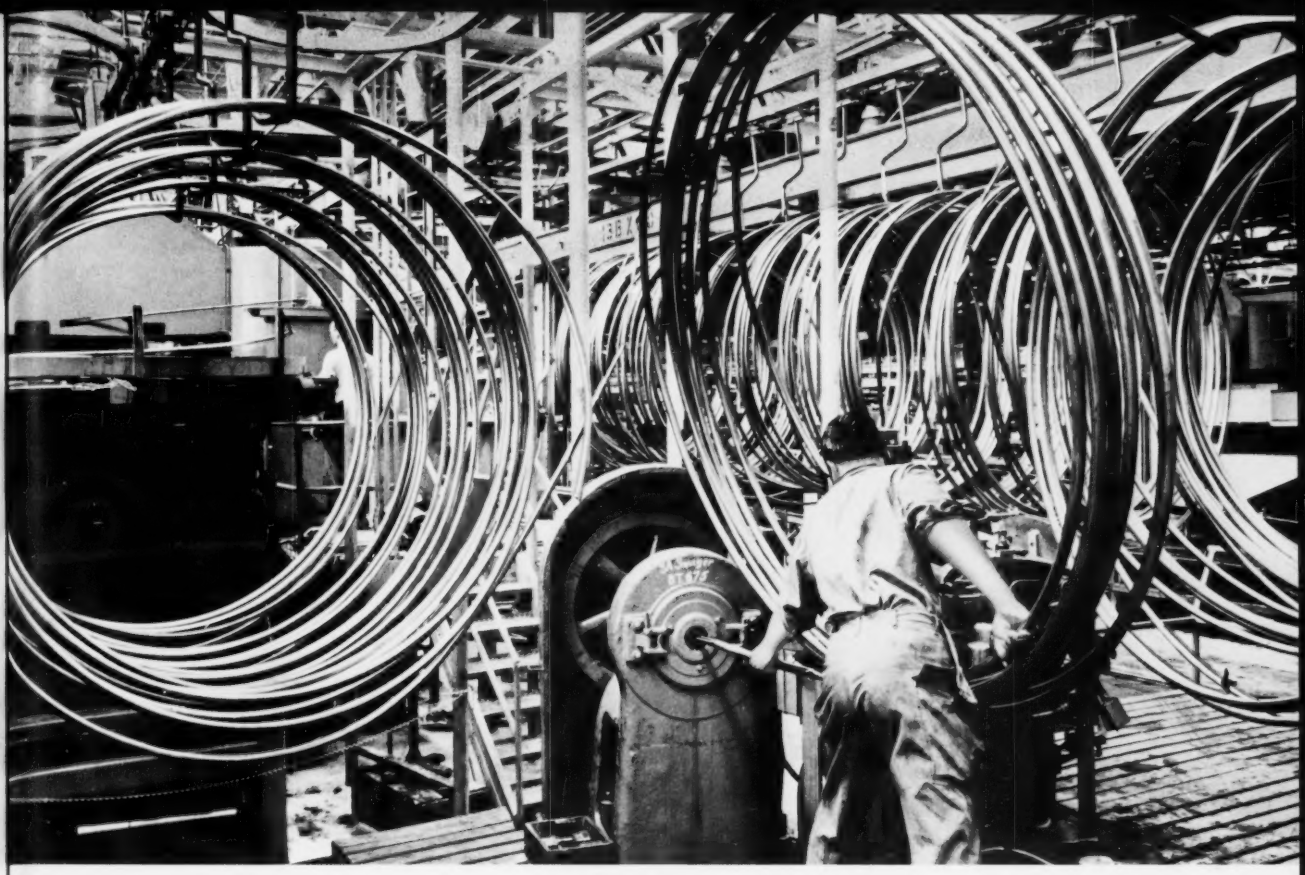
Exide®

INDUSTRIAL MARKETING DIVISION
The Electric Storage Battery Company

ESB

For more facts circle 225 on Reader Service card, p 103

circle 226 on Reader Service card, p 103 ▶



things you should know about

WOLVERINE TUBE

You know what they say–about change being the father of progress.

Well, that's the way it is at Wolverine Tube and we'd like to tell you about some of the new things going on at Wolverine.

For example, Wolverine recently completed a multi-million dollar modernization program at its Detroit, Michigan plant to serve its customers faster and better. New machinery and new tube-making techniques have made this plant one of the most modern in North America. Wolverine also operates large, modern plants in Decatur, Alabama and London, Canada.

There are new things afoot metalwise at Wolverine, too. In addition to copper and aluminum, Wolverine Tube now works in such metals as titanium, zirconium, columbium, tantalum and molybdenum. Wolverine considers this work so important that it has opened a new plant in Inkster, Michigan (Suburb of Detroit) devoted solely to manufacturing and development of these special metals . . . with specific emphasis on titanium and zirconium. It's the result of an extensive research program started many years ago, and it gives Wolverine customers a big edge when they require an experienced tubing and fabrication source for tomorrow's metals–TODAY.

Also, to insure top-flight sales service, Wolverine has expanded its nationwide sales staff to include a number of highly trained Heat Transfer Specialists. These men, along with other members of Wolverine's Field Engineering Service, are specialists in all phases of tubing selection and application, particularly in the field of heat transfer. Their services are available at all times . . . you only have to ask.

So . . . if your company is looking for the finest of tubing and the finest of service, you'll find both at Wolverine Tube where "improvement is a continuing program".

WOLVERINE TUBE
DIVISION OF
Calumet & Hecla, Inc.
DEPT. J, 17268 SOUTHFIELD RD., ALLEN PARK, MICH.
Manufacturers of Quality Controlled Tubing

PLANTS IN DETROIT, MICHIGAN AND DECATUR, ALABAMA
SALES OFFICES IN PRINCIPAL CITIES

BUY WOLVERINE HEAT EXCHANGER TUBE . . . the product of EXPERIENCE

Experience, dependability, engineering, research – if these are the things you look for when specifying heat exchanger tube you'll find them–in full measure–at Wolverine Tube. You'll find, in addition, a wide selection of tubing types–each designed to help you increase heat transfer efficiency. These tubes are illustrated and described on this page. You can choose any . . . or all of them . . . secure in the knowledge that no finer tubing is made. May we have your next order?

PRIME SURFACE TUBE

Wolverine prime surface heat exchanger tube is available in a wide range of sizes in copper, copper alloys and aluminum alloys. It is produced to ASTM Specifications B-111.

DUPLEX PRIME SURFACE TUBE

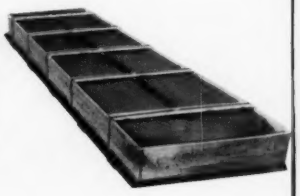
Composed of inner and outer tubes of dissimilar metals this tubing is specifically designed to handle two different corrosive conditions at the same time. The metal combinations can be those required to combat your corrosion problems.

WOLVERINE TRUFIN® – THE INTEGRALLY FINNED TUBE

Wolverine Trufin — the original integrally finned tube is manufactured in 7 different types. It is available in external helical low or high fin form or with internal, longitudinal fins. Your Wolverine Sales representative will give you the *complete* story — just ask him next time he calls.

WOLVERINE U-BEND PALLETS

Here is real convenience. Working to your specifications, Wolverine prefabricates these tubes and ships them to you in disposable box-type pallets — *in* the exact order of unit installation. They're real time savers that also help you reduce tube inventory. Wolverine U-bends are available in both finned or prime surface form.



WOLVERINE FIELD ENGINEERING SERVICE

This is a Wolverine "extra"—a staff of highly trained tubing technicians, ready at all time to help you solve heat transfer problems dealing with tubing alloys, corrosion or design. Just ask for their services . . . there is no obligation.

WOLVERINE TUBE
DIVISION OF
Calumet & Hecla, Inc.
DEPT. J, 17268 SOUTHFIELD RD., ALLEN PARK, MICH.

PLANTS IN DETROIT, MICHIGAN AND DECATUR, ALABAMA.
SALES OFFICES IN PRINCIPAL CITIES

OVER 50 LimiTorque VALVE OPERATORS ARE USED

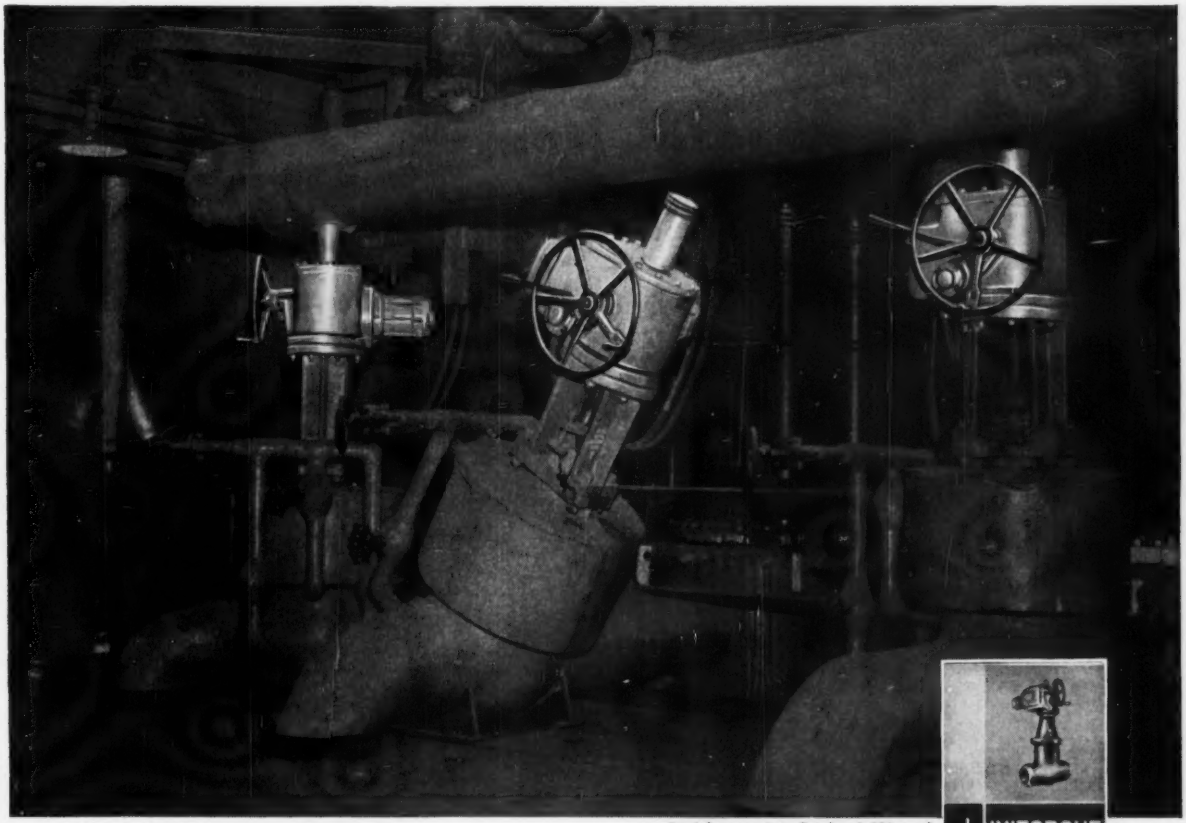
. . . in the East River Generating Station of Consolidated Edison Co.

The illustration below shows three LimiTorque Motorized Valve Operators used on 12" water inlet valves to high pressure feed water heaters . . . there are nearly fifty other LimiTorque Operators used throughout this modern station for various high pressure purposes, on valves ranging up to 20" diameter. We are proud that this modern generating station, like numerous others throughout the world, has chosen LimiTorque Motorized Operators to control their important valves—speedily, safely, surely and economically.

LimiTorque Valve Controls can be mounted on any size valve in nearly any position or location, and they can be readily adapted to existing equipment with electricity, hydraulic pressure, air or high pressure natural gas used as power sources.

LimiTorque provides constant seating thrust . . . assuring an absolutely tight valve on each closure while at the same time, protecting all valve operating parts from overload. Adjustment of the torque limit switch enables operating personnel to compensate for valve wear throughout the life of the valve.

Contact your valve manufacturer, or nearest LimiTorque sales-engineering office.



Send for complete Catalog L-550, and please use your Business Letterhead when requesting a copy.

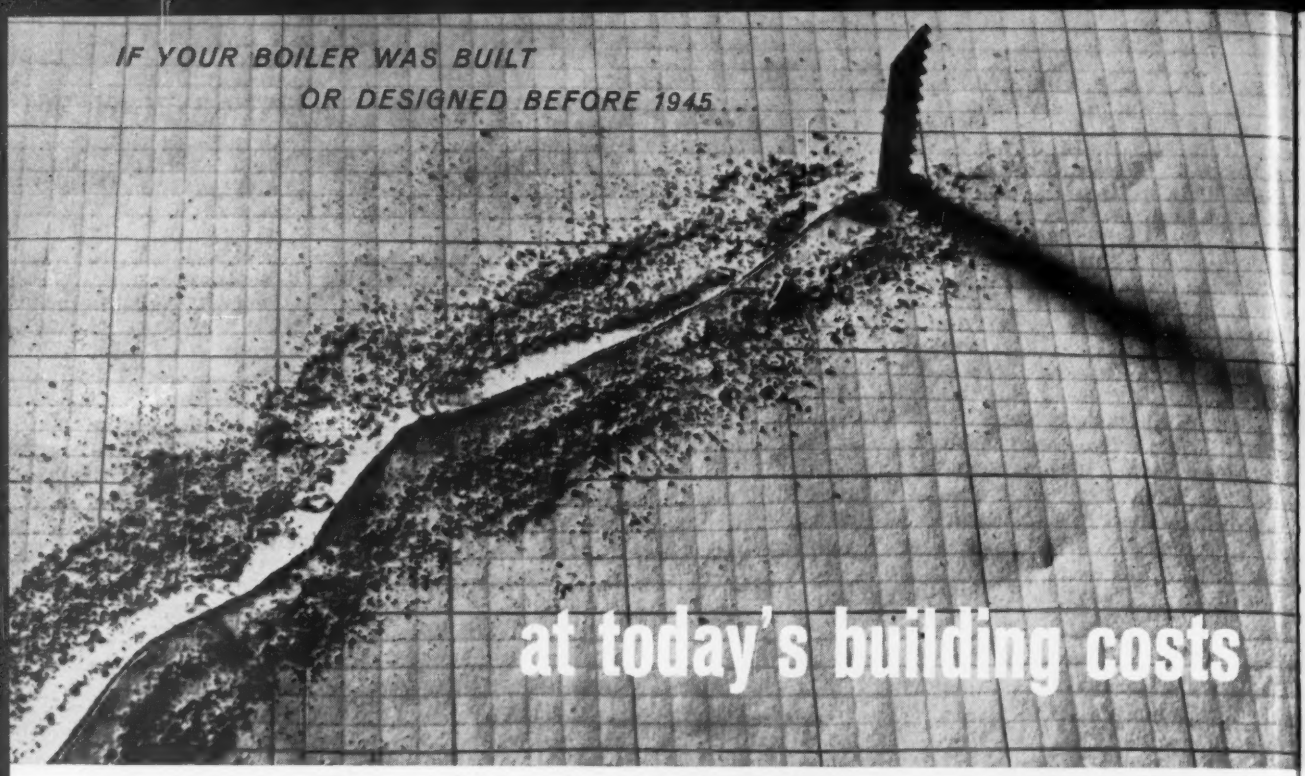
THERE IS NO SUBSTITUTE FOR —

LimiTorque®

PHILADELPHIA GEAR CORPORATION
KING OF PRUSSIA (SUBURBAN PHILADELPHIA), PA.
Offices in all Principal Cities

INDUSTRIAL GEARS & SPEED REDUCERS • LIMITORQUE VALVE CONTROLS • FLUID AGITATORS • FLEXIBLE COUPLINGS
Limitorque Corporation • King of Prussia, Penna.

For more facts circle 227 on Reader Service card, p 103



you may be paying for it a second time!

Today, with building costs twice what they were in 1945, your big, old boiler — possibly coal-fired — can cost you money by occupying space that might be used for other needs.

To offset these climbing construction costs and meet the compact requirements of modern architecture, one manufacturer, Cleaver-Brooks, has proved that big boiler performance and capacity can be engineered into a compact boiler package. Today's CB packaged boilers — in addition to solving unusual installation problems, such as low headroom — are releasing sizeable ground-level areas for production or storage purposes. In some cases, "penthouse" installations have utilized space on an upper floor and *completely eliminated* the use of ground-level space.

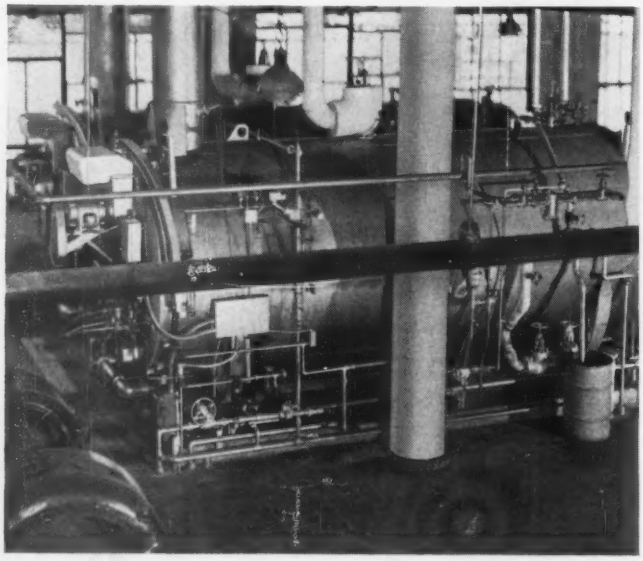
Here are some of the design features that combine for maximum space-saving: four-pass design, forced-draft combustion, updraft construction and all the advantages of five square feet of heat-transfer surface per boiler horsepower. These standards of quality and compactness are only available from Cleaver-Brooks, manufacturers of the most compact, fuel-saving packaged unit on the market.

Cleaver-Brooks boilers are completely pre-engineered and tested as a package . . . expertly started for you by a trained field engineer. Sizes through 600 hp . . . oil, gas and combination oil-gas firing . . . larger sizes in Cleaver-Brooks Springfield water-tube boilers.

Ask your local Cleaver-Brooks agent for more details or write for the booklet, *How to Select a Boiler.*

BOILER ROOM CONVERTED TO WORK AREA

Robert A. Johnston Company, cookie, candy and chocolate products manufacturer in Milwaukee, Wisconsin, replaced four coal-fired boilers with two fully automatic, gas-fired CB boilers. Mr. James Vida, plant engineer, reports: "Compact Cleaver-Brooks design made it possible for us to install the boilers in another part of the plant — in an area of only 750 sq. ft. — releasing the old boiler room, 9000 sq. ft., for storage and work areas. It saved us the cost of an expansion project."



Cleaver Brooks®

ORIGINATOR AND LARGEST PRODUCER OF PACKAGED BOILERS

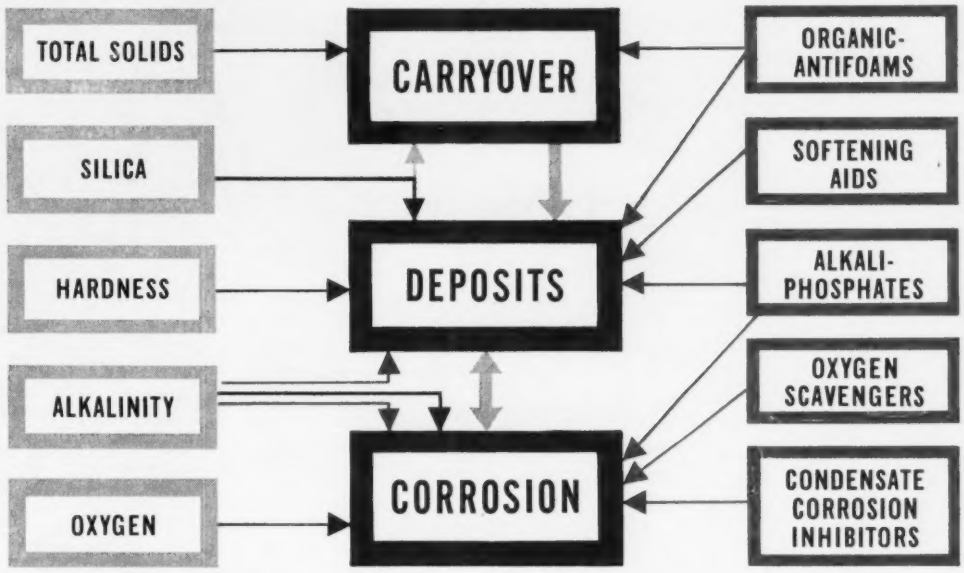
CLEAVER-BROOKS COMPANY

Dept. B, 301 E. Keefe Ave., Milwaukee 12, Wisconsin

For more facts circle 228 on Reader Service card, p 103

BOILER WATER TECHNOLOGY...

Simplified Diagram of a Complex Problem... And Some Suggestions for Getting Satisfactory Answers



This capsule diagram shows the three main problems which can be controlled by proper chemical treatment programs for boiler and steam systems. These problems are caused primarily by the feedwater contaminants shown on the left. Pretreatment of make-up water by ion exchange or other process can reduce or remove one or more of these contaminants. Treatment within the system with the chemicals shown on the right effectively counteracts the effects of the impurities.

All boiler water treatment is aimed at preventing pickup of impurities by water, removing the impurities, or counteracting their effects. This simple statement of the jobs water treatment has to do gives no hint of the millions of manhours and dollars spent in research, testing and field experience – a great deal of it by Nalco – in efforts to reach these goals dependably and economically in all types and sizes of steam systems.

Your water treatment program should fit your particular needs

There are countless combinations of chemicals, equipment and methods for effectively treating boiler feedwater. Yet there is *one* combination that will prove to be the best for *you*.

It is the responsibility of Nalco people to know and understand all the possible approaches to the prevention of corrosion, deposits, and carryover. But their greater responsibility is to couple this technical understanding with a practical understanding of your particular needs.

That is why the Nalco Representative you call in will, first of all, determine the *quality* of water your plant needs. Whether it is merely hardness reduction, or complete demineralization, chances are his technical ability will enable him to develop a number of ways to produce it. But, most important – he has the practical understanding to know *which* of those methods is the most efficient and economical – *the most practical method* – for you.

A Nalco Program Based on Results

A Nalco program of water treatment for your plant is based on *all* the elements which affect results: chemical, mechanical, and operating factors. To do this, Nalco field personnel bring the full weight of unexcelled water treatment research and development, vast field experience, and specialized training and skills into use to recommend a program with one aim: the lowest overall cost *consistent with best results.*

Once established, your water treatment program includes regular checks by your Nalco Representative . . . Nalco believes that water treatment responsibility is continuous – and the thousands of Nalco-treated plants, many of them Nalco customers without a break for thirty years and more, are ample evidence that this belief works well in practice.

For prompt action on a Nalco program for your plant, call your Nalco Representative today or write:

NALCO CHEMICAL COMPANY
6222 West 66th Place • Chicago 38, Illinois

Subsidiaries in England, Italy, Mexico, Spain, Venezuela and West Germany
In Canada: Alchem Limited, Burlington, Ontario

Nalco® ... Serving Industry through Practical Applied Science

Nalco CHEMICALS
Nalco SERVICES

For more facts circle 229 on Reader Service card, p 103

send for bulletin no. 4

easier to maintain

easier to install . . .

Striking new economies are now available for commercial, industrial and institutional buildings with P-K's SCALEFREE 230, the first indirect gas fired storage water heater • **Installation.** A complete and automatic package, P-K's SCALEFREE 230 can be skidded into place, hooked up and checked out quickly. There is no complicated piping or electrical work to run up costs. No stack is needed for extra draft. No foundation is necessary. Factory insulation (optional, as illustrated) further reduces costs and avoids the complications of on-the-site insulating. • **Maintenance.** P-K's SCALEFREE 230 offers new freedom from trouble. It won't scale—and retains its rated efficiency—because heat transfer occurs below the temperature at which scaling minerals precipitate. Linings of Pre-Krete® or copper keep the storage section free of rust and corrosion regardless of water conditions. • P-K's SCALEFREE 230 is available in storage capacities from 250 to 4,000 gallons; recovery sections from 390,000 to 2,215,000 BTU. Bulletin No. 4 gives complete engineering and performance data.

Address your request to: The Patterson Kelley Co., Inc., 82 Morgan Avenue, East Stroudsburg, Pennsylvania.

Patterson Kelley
Water Heater Division

For more facts circle 230 on Reader Service card, p 103

New Economy in a New ANCHOR PRODUCT

Smooth, Black ANKORITE 1000

Ankorite 1000 is an Underwriter's approved electrical insulating tape with all the important qualities of the more expensive tapes. For example, resistance to acids, alkalies, corrosive salts, oil, grease and water is excellent. It resists abrasion, remains flexible, and is unaffected by sunlight. Here are other specifications of this versatile tape:

Dielectric Strength	10000 volts/mil
Insulation Resistance	10^6 Megohms
Tensile Strength	20 lbs/in. width
Elongation	200%
Temperature Range	32°-175°F.

Take advantage of the savings offered by new Ankorite Electrical Tape NO. 1000. For full details, see your Anchor Representative, or contact the Anchor General Office in Philadelphia, today.

Find It Fast in The "Yellow Pages"

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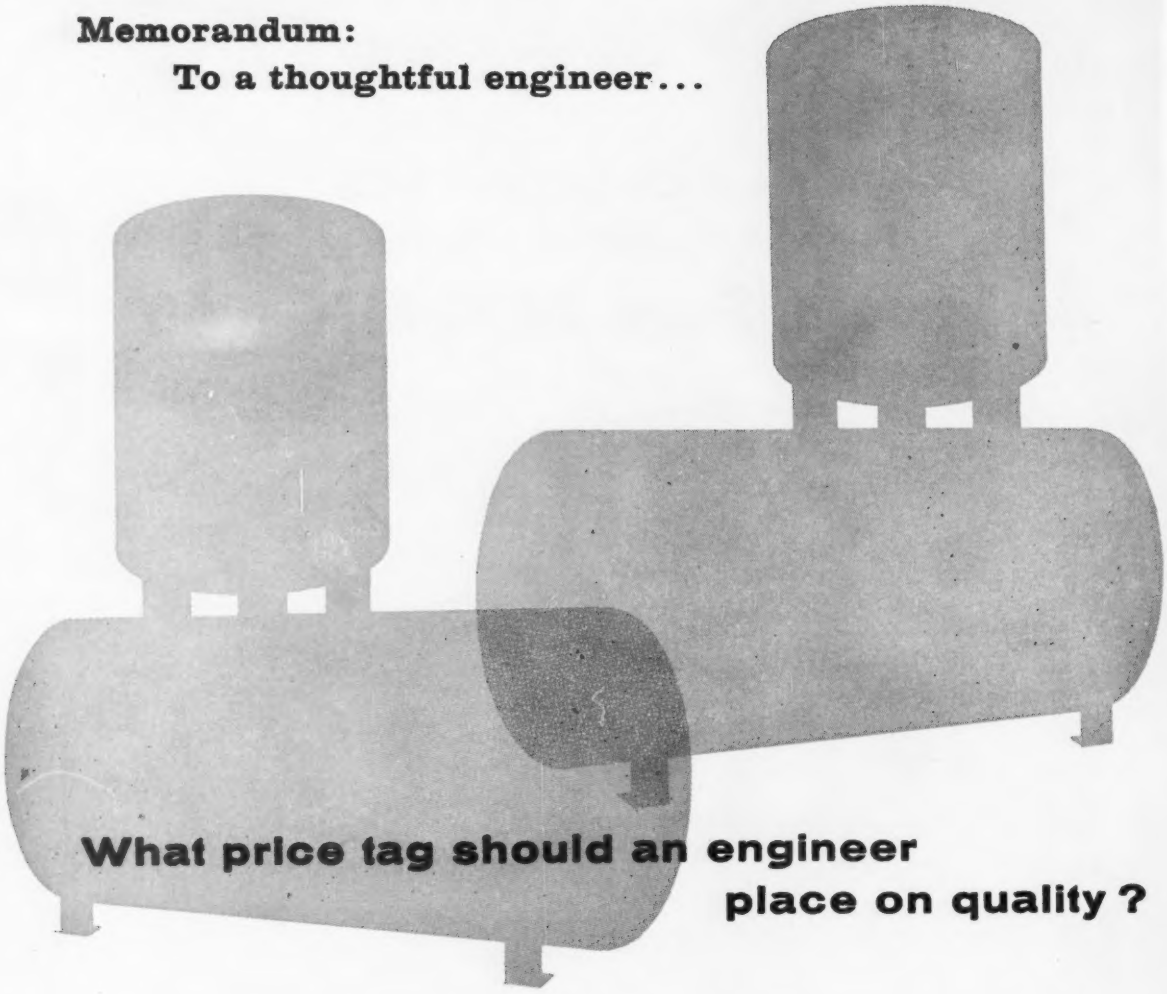
FIBROUS AND METALLIC PACKINGS FOR EVERY INDUSTRIAL PURPOSE

For more facts circle 231 on Reader Service card, p 103

Memorandum:

To a thoughtful engineer...



What price tag should an engineer place on quality?

These two medium sized deaerators look alike. We designed both. They have the same outlet capacity, carry similar guarantees and meet the ASME code. But one costs $2000 more than the other.

Which is the better buy?

Obviously, you would want to know more about each unit in order to make a sound decision. Construction to ASME standards and basic guarantees are but part of the quality story. The higher priced unit, for example, has far heavier shell plate, more tray area and spilling edge, superior shell reinforcement, stainless instead of carbon steel baffle, anti-flash downtake. All of these features, we have found, are important to continued top performance.

As one of the world's largest and most experienced manufacturers of deaerators, we believe we know which unit is the better buy. Extra margins of strength and capacity—wisely selected—are not luxuries but sound investments that eliminate downtime and expensive field repairs.

That is why we recommend *quality*, and why thoughtful engineers insist on *quality*. If you are considering the purchase of deaerating equipment we are prepared to help you evaluate *all* the features that mean *true economy* in service. Ask for Bulletin 4650 on the "Why and How of Deaeration"

Write for these five bulletins on Deaeration—the problem, types of deaerators and applications.

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Representatives in thirty-six principal cities in U.S., Hawaii, Puerto Rico; also Havana, Cuba; Paris, France; La Spezia, Italy; Mexico City, Mexico; Caracas, Venezuela; Santiago, Chile.

POTTSTOWN METAL PRODUCTS WORKS
Custom built carbon steel and alloy products.

Demineralizers • Zeolite Softeners • Hot Process Softeners • Hot Lime Zeolite Softeners • Dealkalizers • Reactors • Deaerators • Pressure Filters
Continuous Blowoff Systems • Condensate Return Systems • Steam Specialties

For more facts circle 232 on Reader Service card, p 103

For trouble-free underground hot pipe insulation specify GILSULATE® with Engineer-Supervised Installation

Every engineer charged with the responsibility of designing a central heating system to heat all buildings of a college, institution or industrial plant knows the money-saving advantages of such a system if properly planned. But he is aware that planning the underground piping can involve many problems, for the system must provide proper insulation and also protect pipes against corrosion, chemical and electrical attack.

The easy, one-step solution to many of the problems of underground hot pipe insulation is to call the GILSULATE distributor in your area: first, for the superior quality of the insulation material he sells and, secondly, for the excellent service he has to offer.

GILSULATE is a naturally-occurring mineral which, because of its unique chemical and physical properties, is chemically neutral in all soils, dielectric, impervious to mold, rodents and plant growth, and is water-resistant. Its thermal efficiency, low installation cost and long service life are supported by extensive laboratory and field research, and also by years of successful use in thousands of installations throughout the world.

Service that saves time and trouble—It is as important to our reputation that GILSULATE be used properly as it is for the engineer to assure his customer of an efficient, economical installation. Our distributors' experienced mechanical engineers will work with you in preparing underground piping plans, checking soil conditions and arranging for supervision of the installation work. And, without any cost to you, plans and specifications will be checked by American Gilsonite's Engineering Department.

Full-time engineer supervision of installations—Every GILSULATE installation of 30 tons or more is supervised by an American Gilsonite Company field service representative who stays on the job until it is completed. Smaller jobs are inspected by the distributor's engineer. This is a guarantee to everyone concerned...owner, architect, engineer, mechanical contractor and materials supplier...that every step of the job will be exactly to specifications.

Without obligation, we will be pleased to send you technical information on GILSULATE insulation so you can evaluate the merits of this low-cost, poured-in-place material. We will also put your name on the mailing list to receive free copies of PIPE INSULATION NEWS.

Once you have learned the merits of GILSULATE, we feel certain you will want to write your "specs" to assure the use of GILSULATE...*with engineer-supervised installation.*

FACTS ABOUT GILSULATE

1. **Easy-to-use**—just pour, shovelpoint and tamp...pipe heat does the rest.
2. **Forms protection against heat loss** and all hazards commonly encountered by buried hot pipes.
3. **Needs no housing or mechanical sheaths:** no mixing, special handling or equipment.
4. **Only needs normal pipe spacing:** for multiple pipe or cramped conditions.
5. **Four types available:**
   Type A for 220-300° F. temp. range
   Type B for 300-365° F. temp. range
   Type Special B for 365-420° F. temp. range
   Type C for 420-520° F. temp. range

THE INSULATION FOR LIFETIME PROTECTION OF UNDERGROUND HOT PIPES

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AMERICAN GILSONITE COMPANY

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Affiliate of Barber Oil Corp. & Standard Oil Co. of California
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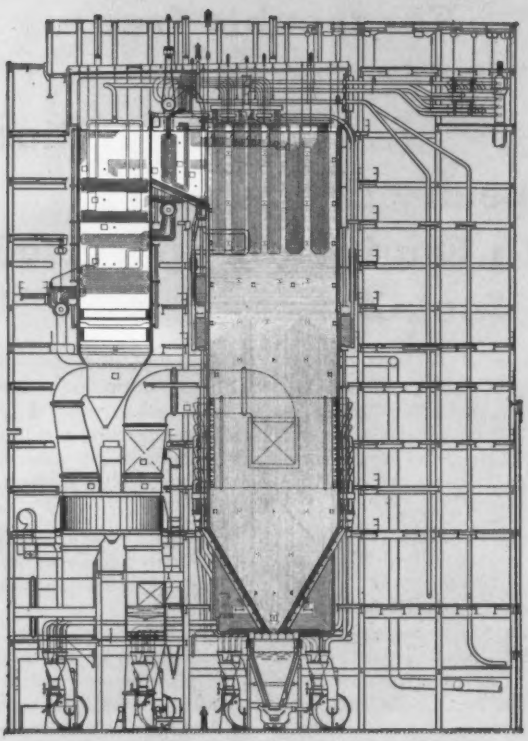
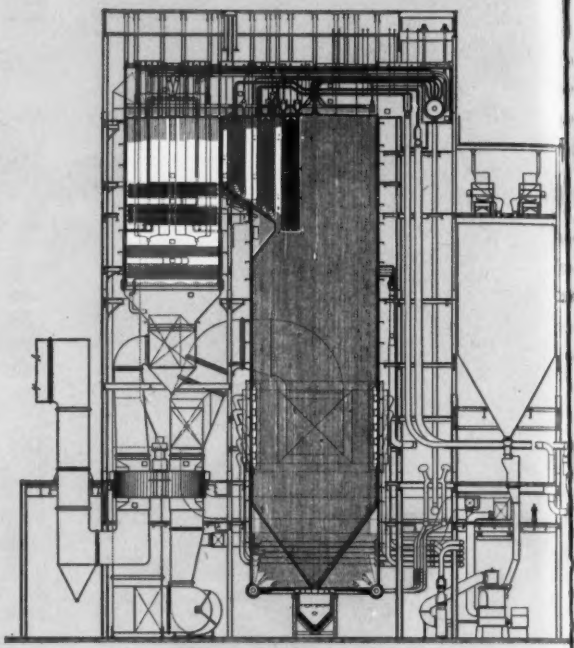


The unit pictured here represents the most advanced power plant cycle yet attempted. This boiler, a C-E Sulzer Monotube Steam Generator, is designed to deliver 1200 F steam at a pressure of 5000 psi to a 325-megawatt turbine-generator. The unit employs a double reheat cycle (1050 F—1050 F) and has a primary steam flow of 2,000,000 lb per hr. It went on the line in February, 1960.



This boiler, a C-E Controlled Circulation unit, serves the world's first 500-megawatt turbine-generator. Designed for a primary steam flow of 3,850,000 lb per hr, it delivers 1050 F steam (1000 F reheat) at 2450 psi. It was placed in service in 1960.

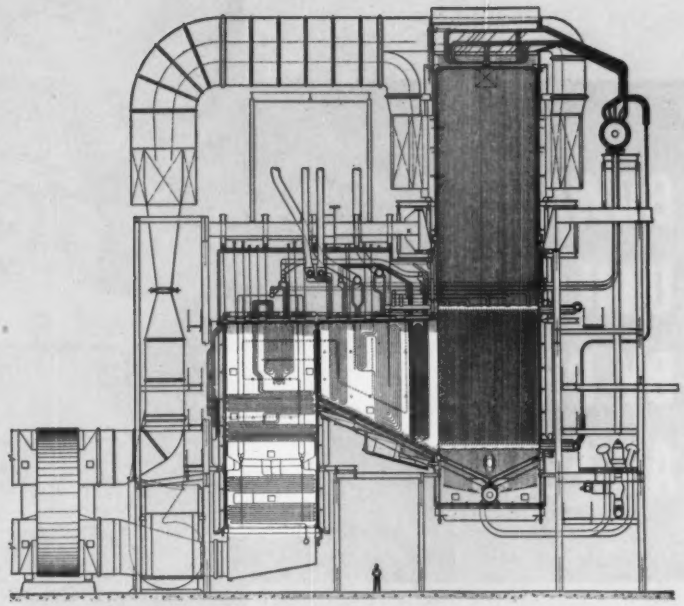
PROFILES

In 1950, a decade ago, Combustion installed some 40 utility boilers, representative of the complete range of power practice at that time. The average turbine capacity was 50 megawatts . . . the largest, 120 mw. All boilers were of natural circulation design, only two used reheat, only two had design pressures as high as 1800 psi. By contrasting these statistics with those of the boilers shown above, the length of the strides taken in the last ten years can be more fully appreciated.

A broader picture of current practice is revealed by the following data relative to 1960 C-E utility installations, which will serve nearly 4,000 mw of new capacity. Six of these boilers will power turbines of 225 mw and above, the largest serving a 500-mw turbine. All but two are designed for pressures in excess of 1800 psi . . . all employ reheat . . . about 60 per cent are of Controlled Circulation design. More than 70 per cent of the units serve turbines with capacities from 150 mw up. In fact, the average unit size is more than three times that of ten years ago, and the largest has

ALL TYPES OF STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT; NUCLEAR REACTORS;

Shown here are three C-E boilers, each of which represents an advanced design concept. Their major points of difference concern capacities, cycles, configurations — considerations of major import in the industry's continuing effort to keep power costs down. As indicated by the picture captions, one unit (far left) is the world's highest pressure boiler and represents the most advanced and efficient cycle yet attempted in power plant practice. Another (left) is the world's largest boiler, serving the first 500-megawatt turbine-generator to go into service. Both of these units went "on the line" in 1960. Although different in design, both follow the same general pattern which has long been characteristic of large C-E utility boilers. The third boiler (right) represents a marked departure from this classic arrangement. Because of the flexibility of its C-E Controlled Circulation design, heating surface can be placed in almost any desired position. Thus, it becomes possible to effect sizable savings in structural steel, stairs, platforms, piping, earthquake-proofing, as well as in the boiler itself.



This new look, made possible by the flexibility inherent in C-E Controlled Circulation design, holds much promise of bringing new first-cost economies to power plant practice. This reheat boiler is designed to deliver 1050 F steam (1000 F reheat) at 2400 psi to a 300-megawatt turbine-generator. It has a primary steam flow of 2,305,000 lb per hr.

S of Power Progress

over four times the capacity of the biggest unit of 1950.

During the last decade, the vocabulary of the power plant has been enlarged with the addition of such words and phrases as "skin casing," "divided furnaces," "twin furnaces," "panel wall," "welded wall," "subcritical," "supercritical," "platens," "pressurization." They account, in large measure, for the fact that, while generating costs have risen considerably over the last ten years, the average net production cost per kw-hr is substantially less today than it was in 1950.

COMBUSTION ENGINEERING

C-298

General offices: Windsor, Connecticut
New York offices: 200 Madison Avenue, New York 16

PAPER MILL EQUIPMENT; PULVERIZERS; FLASH DRYING SYSTEMS; PRESSURE VESSELS; SOIL PIPE

For more facts circle 234 on Reader Service card, p 103

BOWATERS UTILIZES BY-PRODUCT WASTE AS FUEL

At Bowaters Carolina Corporation, Detroit RotoGrate Stoker, with 6 Detroit air swept spout refuse distributor feeders, installed under Babcock and Wilcox 2 drum single pass steam generator. Steam is produced at 850 psig, 900° F-T.T. Feedwater temperature 300° F. Combustion air temperature is 350° F.

Bowaters Carolina Corporation's new plant at Catawba, South Carolina uses a Detroit RotoGrate Stoker to burn bark refuse under a steam boiler. The installation is designed to produce 200,000 pounds of steam per hour when burning bark alone.

Costly waste disposal measures, which in years past were common to pulp mill operation, have been eliminated.

Provision is made for future firing of coal either in conjunction with bark or separately, and 275,000 pounds of steam will be produced with this combination. Peaks of 300,000 pounds of steam are anticipated.

Oil and gas burners in the furnace walls are presently used for auxiliary firing if refuse fuel is not available in sufficient quantity to supply the demand for steam.

Versatile in their ability to burn a broad variety of fuels . . .

DETROIT ROTOGRATE STOKERS

. . . have an established reputation for efficient performance.

8417

DETROIT STOKERS COST LESS: Cost equals initial investment plus upkeep plus production losses due to equipment outage. *The total is less with Detroit.*

DETROIT STOKER COMPANY

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Another addition to the Vogt line of TOP QUALITY valves . . .

Forged Steel
WELDED BONNET

GENERAL GP PURPOSE

Gate and Globe
VALVES

150-800 Pounds Service

To eliminate forever potential body-bonnet leaks, Vogt engineers have developed these new General Purpose valves with seal welded bonnet joints.

This new addition to the world's most complete line of forged steel valves incorporates all the features of other Vogt GP valves—hard faced seats, hardened stainless steel wedges, drop forged pressure parts, and the numerous other advantages of Vogt's valve line.

The desirable safety feature of a back seat on the stem is retained while still offering the elimination of a possible body-bonnet leak.

Available NOW in both gate and globe types, ¼" thru 2", and in both socket weld and screw ends. These are priced identical to the bolted bonnet GP valves; gate valves the same as Series 12111 and globe valves the same as Series 12141.

Address Dept. 24A-FP for literature

Series 2801 Gate Valve
Illustrated

Series 2821 Globe Valve
Also Available

Both series identical in dimensions and have 13% chrome stainless steel trim.

Vogt

GENERAL GP PURPOSE — Vogt FOR BETTER VALVES

HENRY VOGT MACHINE COMPANY, Louisville, Ky.

SALES OFFICES: New York, Chicago, Cleveland, Dallas, Camden, N. J., St. Louis, Charleston, W. Va., Cincinnati.

FORGED STEEL
VALVES

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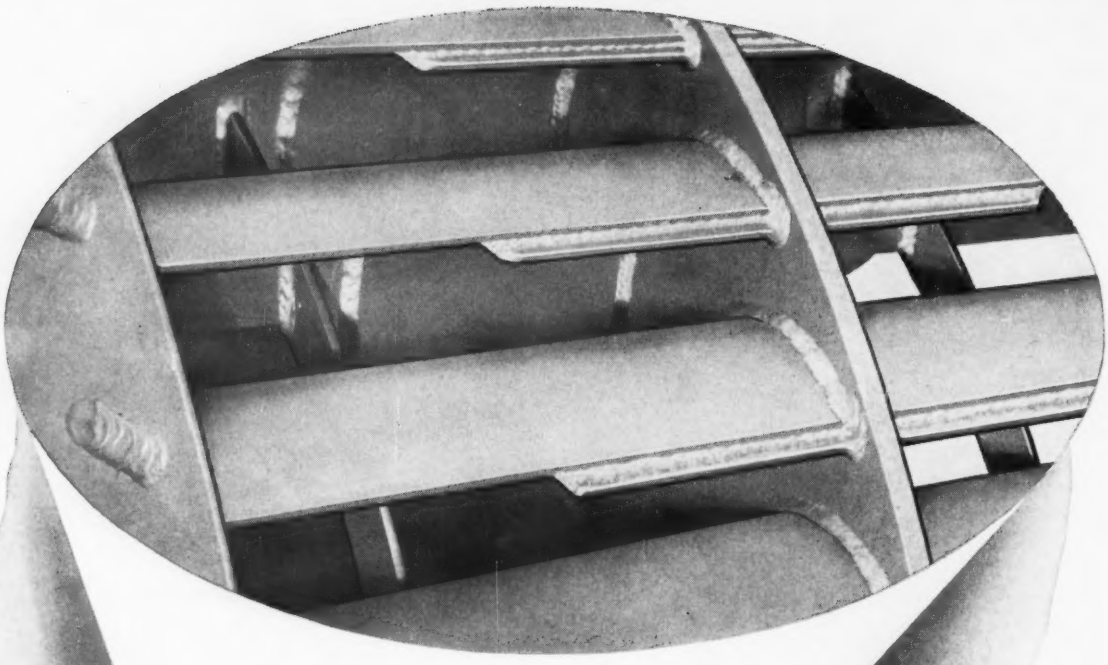
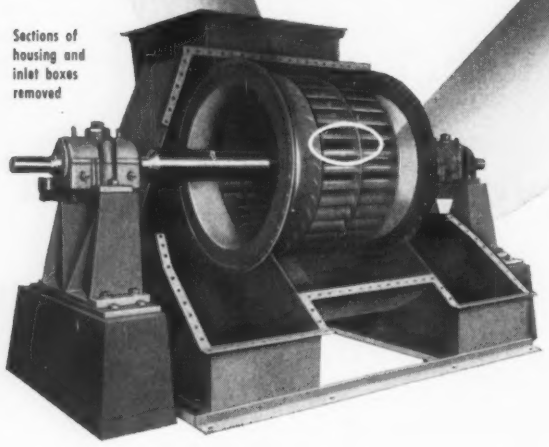


RIGHT WHERE THEY BELONG . . . . . *wearing plates on the FACE of the blades*



Sections of housing and inlet boxes removed

Here's another feature you get only from Clarage. The Type DN Dynacurve induced draft fan, when equipped with wearing plates, has these abrasion-resisting steel plates welded to the *face* of the wheel blades.

Result: *extra* service life.

Don't settle for less. Choose the Clarage Dynacurve fan with its rugged wheel of 36 radially deep blades . . . minimum floor space and height requirements . . . bolted scroll liners for easy replacement . . . and numerous other distinctive features.

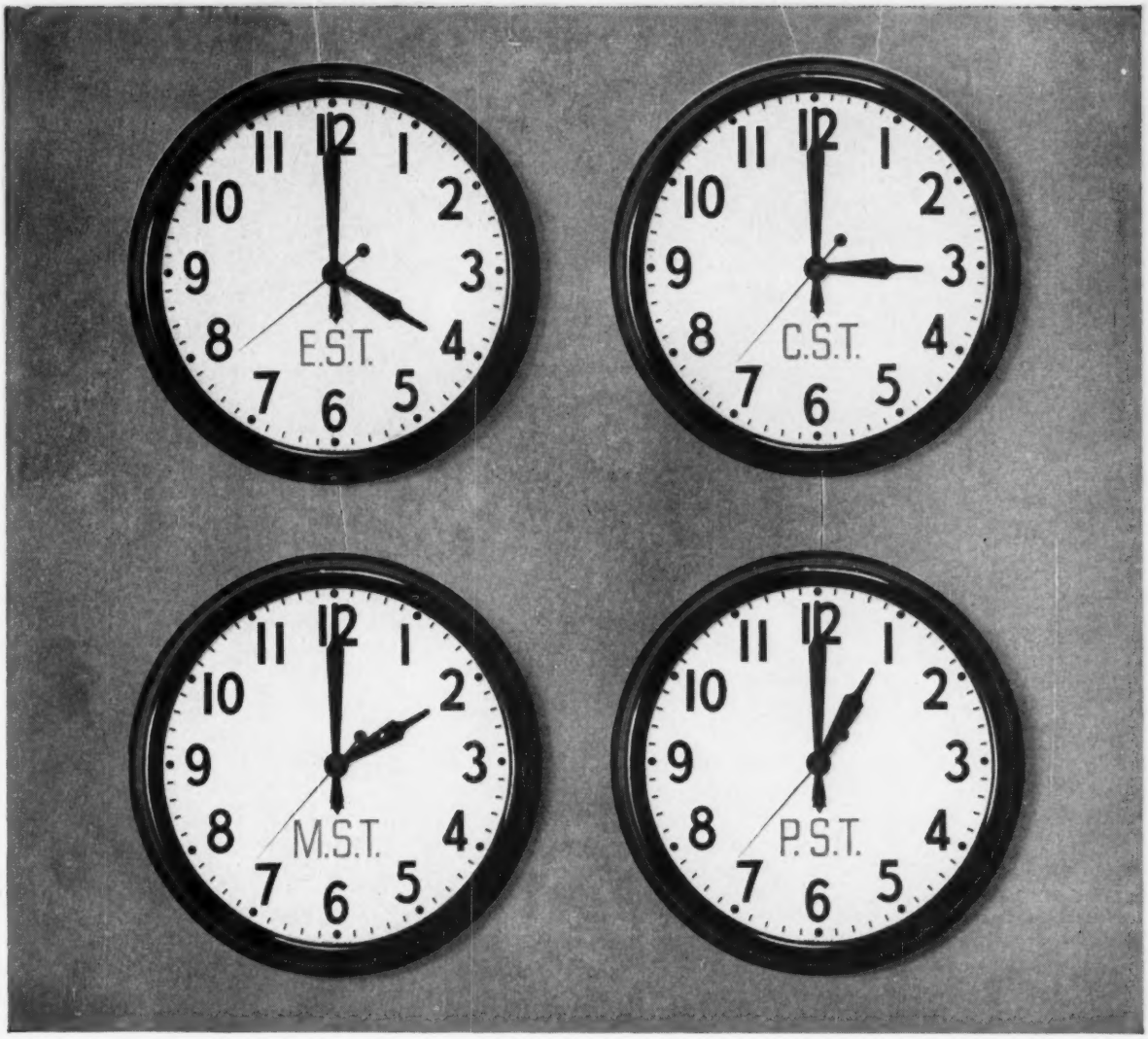
Contact our nearest office for complete data.

Dependable equipment for making air your servant

CLARAGE FAN COMPANY

Kalamazoo, Michigan

SALES ENGINEERING OFFICES IN ALL PRINCIPAL CITIES • IN CANADA: Canada Fans, Ltd., 4285 Richelieu St., Montreal



ONLY MORTON OFFERS A COAST-TO-COAST SALT SERVICE FOR EVERY WATER CONDITIONING NEED!

Wherever your plant is located, whatever salt you need and whenever you need it, Morton, America's only nation-wide salt company, can provide you with the kind of salt and service to keep your brinemaking equipment working at top efficiency!

MORTON PUREX is a quality controlled evaporated grade of salt that is 100% soluble. Purex dissolves rapidly and uniformly, producing a clear, fully saturated brine at highest possible flow rates.

MORTON '999' is a high-purity evaporated salt. It is particularly suitable for use in de-alkylizing units.

MORTON ROCK SALT is economical to use and comes from many sources in a wide range of particle sizes. Morton can supply the grade best suited to your needs.

Mail coupon today for more information about the various grades of salt and the valuable service Morton offers the Water Conditioning Industry.

Please send me additional information on

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MORTON SALT COMPANY

INDUSTRIAL DIVISION

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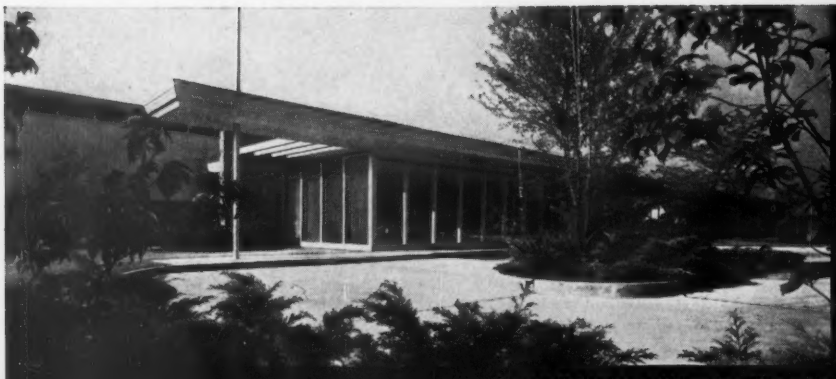
For more facts circle 238 on Reader Service card, p 103



Square D Company, Milwaukee, Wisconsin

Western Electric Company, Inc., Baltimore, Maryland

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INDUSTRY DEPENDS ON

Increased productivity, lower employee turnover, reduced absenteeism, improved machine efficiency, better quality control — all these and more often are possible in modern industrial plants that have a closely controlled thermal environment.

Johnson Pneumatic Control Systems have a notable record for providing dependable, trouble-free operation of all types of industrial air conditioning, heating, and ventilating systems. Thousands of leading plants such as those shown here depend on specially planned Johnson Systems to meet their individual temperature and humidity control requirements.

Johnson manufactures the most complete line of pneumatic controls for solving any problem of temperature, humidity, or pressure control. And, to make certain that each installation continues to perform up to expectations, Johnson maintains the largest and most experienced service organization in its field.

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JOHNSON PNEUMATIC CONTROL

Let Johnson help provide a more productive thermal environment in your plant. Whether your problems involve comfort control or the regulation of process air conditioning, a specially engineered and installed Johnson Pneumatic Control System is the answer. Your consulting engineer, architect, or local Johnson representative can give you full details. Johnson Service Company, Milwaukee 1, Wisconsin. Direct Branch Offices in 105 Principal Cities.

JOHNSON CONTROL

PNEUMATIC SYSTEMS

DESIGN • MANUFACTURE • INSTALLATION • SINCE 1885

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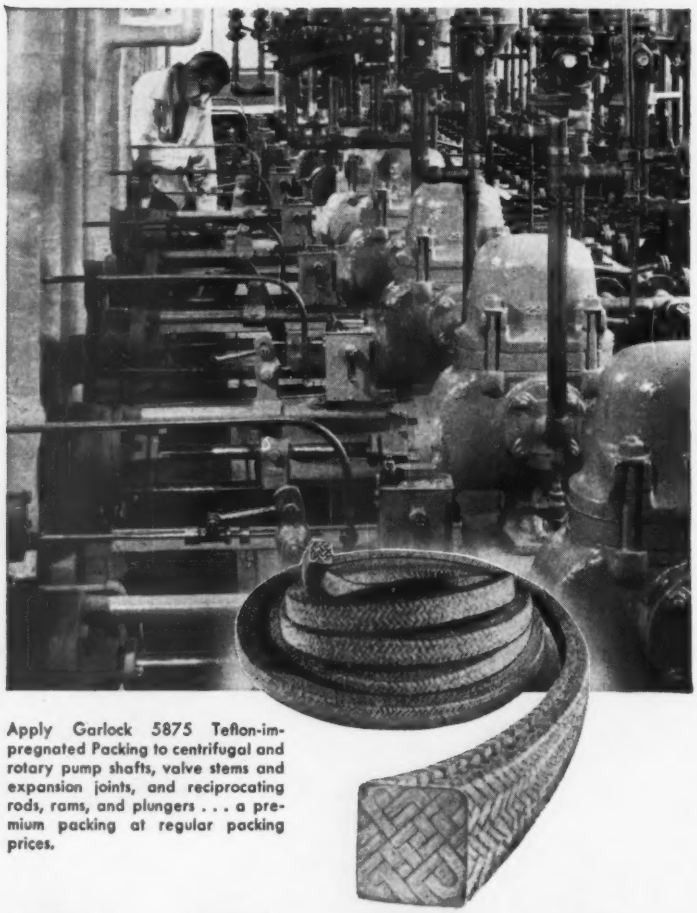
ENGINEERED TEFLON PRODUCTS



Apply Garlock 5875 Teflon-impregnated Packing to centrifugal and rotary pump shafts, valve stems and expansion joints, and reciprocating rods, rams, and plungers . . . a premium packing at regular packing prices.

NOW—YOU CAN BUY GARLOCK TEFLON* PUMP PACKING AT REGULAR PACKING PRICES!

Through an improved manufacturing technique, Garlock offers a Teflon-impregnated LATTICE BRAID† Packing at a reduction of approximately 40% over the price of similar competitive packing. Designated Garlock 5875, this packing can be purchased at prices comparable to regular packing.

Enjoy premium benefits without a premium price. Garlock 5875 offers a high Teflon content—more than 30% by actual weight—for greater protection, reduced wear. In temperatures from −90° F to +500° F, Teflon-impregnated LATTICE BRAID Packing is recommended for use against moderately destructive and corrosive mineral acids and caustics. For more destructive and corrosive applications, Garlock 5888 Teflon-treated fiber packing is recommended. Teflon, too, is as "frictionless" a material as you will find; this greatly reduces wear to the packing itself, and to any moving parts that it contacts during normal operation.

Specialized construction provides longer life, less maintenance. Garlock 5875 Packing is made from Teflon-impregnated white asbestos yarn, woven in the superior LATTICE BRAID construction. Here, each strand of treated yarn is intertwined at a 45° angle through the packing body. This completely integrates the structure for greater strength and, unlike ordinary square or round braid, eliminates individual *layers* of yarn—layers that, once worn through, destroy the usefulness of the packing. Without a layer or single outer braid to wear through, LATTICE BRAID remains unified without disintegrating far beyond the limits of other packings.

Enjoy fast delivery from warehouse stock. Garlock 5875 Packing is immediately available in sizes from ¼" through ⅝" in either spool or reel form to meet your specific needs; also available on order in ring form in these sizes. Specify now from your local Garlock representative at the nearest of the 26

GARLOCK

Garlock sales offices and warehouses throughout the U.S. and Canada. Or, for more information, write for Catalog AD-185, Garlock Inc., Palmyra, New York.

Canadian Div.: Garlock of Canada Ltd.
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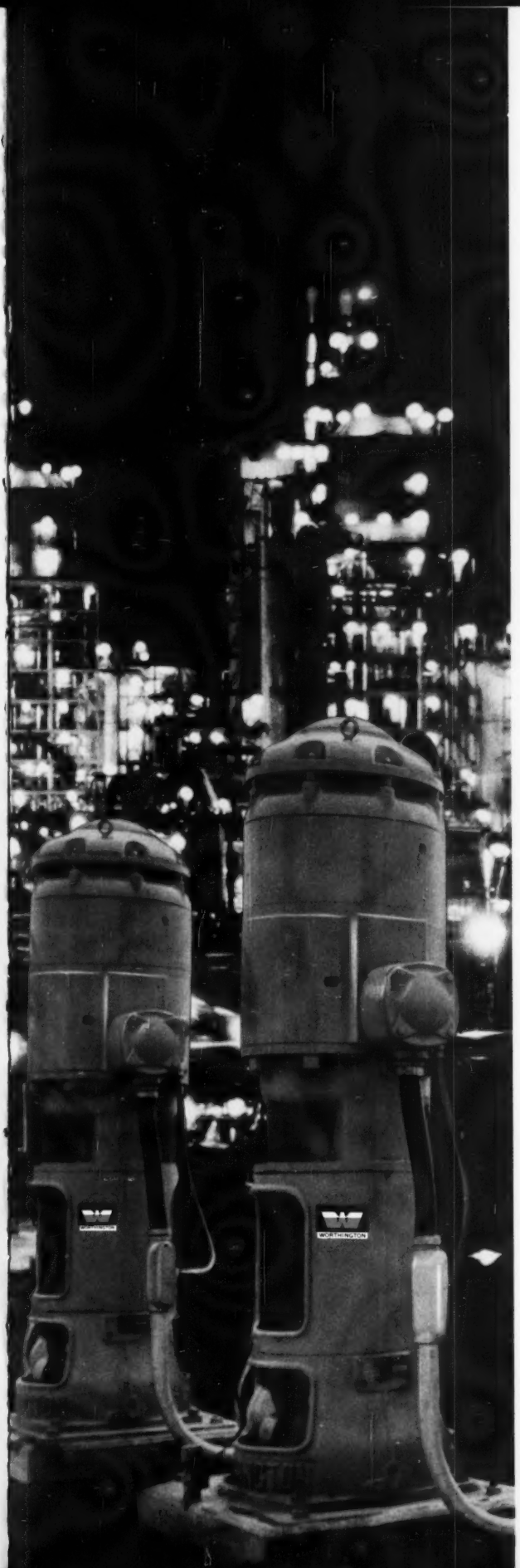
Order from the Garlock 2,000 . . . two thousand different styles of Packings, Gaskets, Seals, Molded and Extruded Rubber, Plastic Products.

*DuPont Trademark for TFE Fluorocarbon Resin
†Registered Trademark

For more facts circle 240 on Reader Service card, p 103
circle 241 on Reader Service card, p 103 ▶



Up to 4% more efficient... it costs less to operate vertical pumps with UHF design

Yes, UHF design in vertical pumps produces a new higher performance level. So high, in fact, that your power saving is frequently equal to one hour of free operation in each twenty-four.

Here's how UHF design achieves this new level in vertical pump performance . . .

Higher efficiency over wider operating range cuts power costs . . .

Today Worthington UHF design gives unexceeded—frequently unequalled—peak efficiency. This alone cuts your power costs sharply. But most important, the peak of a UHF-designed efficiency curve is broader . . . flatter on top. This cuts costs by maintaining a much higher average efficiency over the normal fluctuations in system capacity and head.

Look at the chart at the right, comparing an ordinary pump with UHF design. The efficiency of the UHF-designed pump remains higher through a much broader range of the head-capacity curve. Or, at any given operating point away from peak, its efficiency will exceed that of the ordinary pump. Either way you save appreciably on power.

UHF design most closely covers system requirements

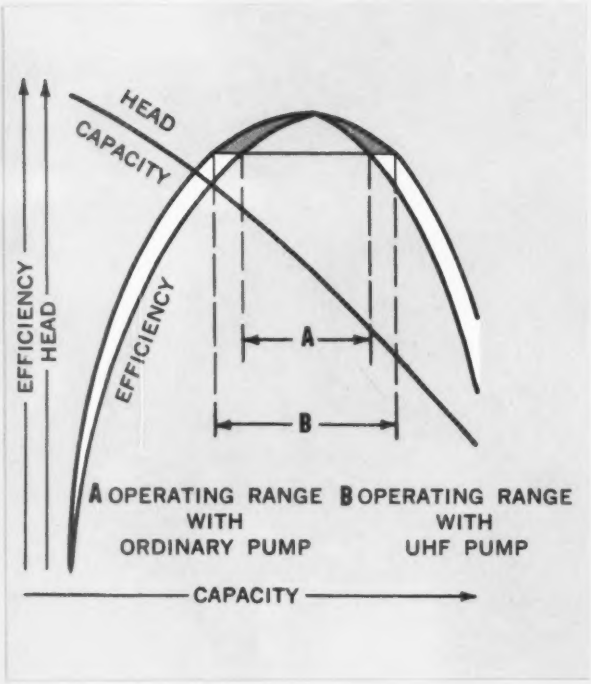
The UHF line covers every design point with not one, but three or more performance curves. This fully recognizes requirements of different systems. And it assures you of more satisfactory, more economical performance.

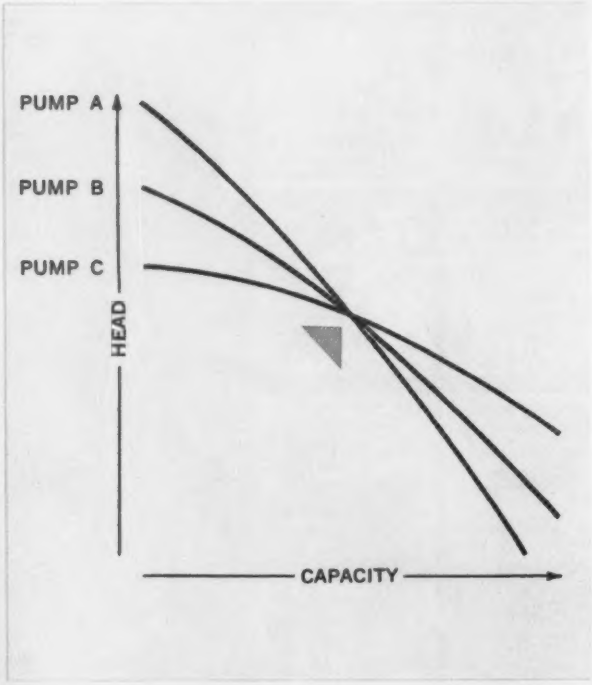
Here's how. In the chart at the right, the UHF-designed pump covers the design point with three different head-capacity curves. Pump "A" maintains relatively constant flow in spite of pressure changes. Its curve is typical of those required, for example, by circulating water pumps from which a constant flow is required, regardless of pressure changes.

On the other hand, pump "C" might serve a municipal water supply. There a relatively constant pressure is required despite variations in demand. Pump "B" is suitable for intermediate requirements.

What is the cost saving?

If UHF design gives you as little as a 1% increase in average efficiency during an 8,000-hour year, you will save: $200 on a 124 hp pump; $560 on a 350 hp pump; and $800 on a 500 hp pump.





NEW VERTICAL PUMP WITH UHF* DESIGN

RUNS FREE ONE HOUR EACH DAY

*ULTRA HIGH FLOW

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NAME

COMPAN

STREET

CITY

UHF-designed pumps run longer with higher sustained performance

Peak efficiency at start-up is just the hydraulic half of the UHF design story. The construction is extremely important, too, because UHF design means less taper-off in pumping efficiency during operation, and reduced maintenance.

For example, you'll find UHF shafts are frequently 10 to 40% heavier than competition. Thus even at maximum horsepower, shaft and bearing wear is negligible in UHF pumps.

Another major design advantage is in impellers. The closed impellers used in UHF pumps reduce axial thrust by about 50% over open impellers. This greatly reduces thrust bearing loads, extending bearing life.

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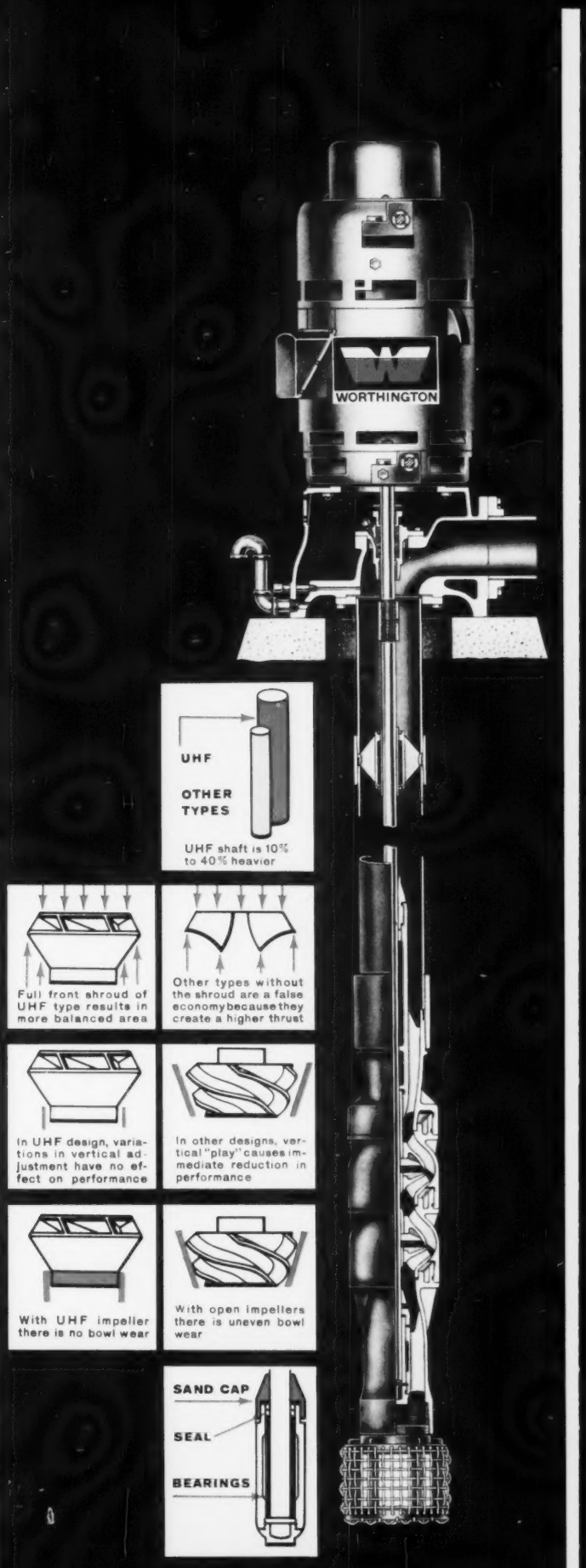
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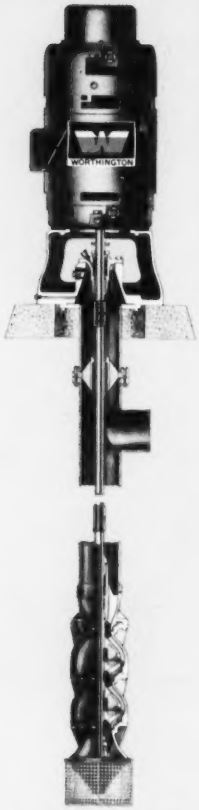

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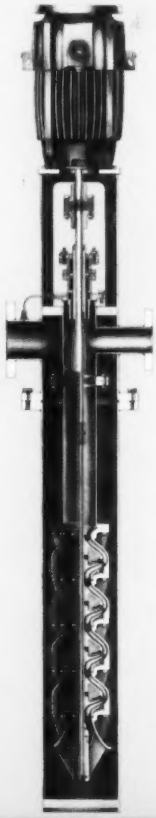

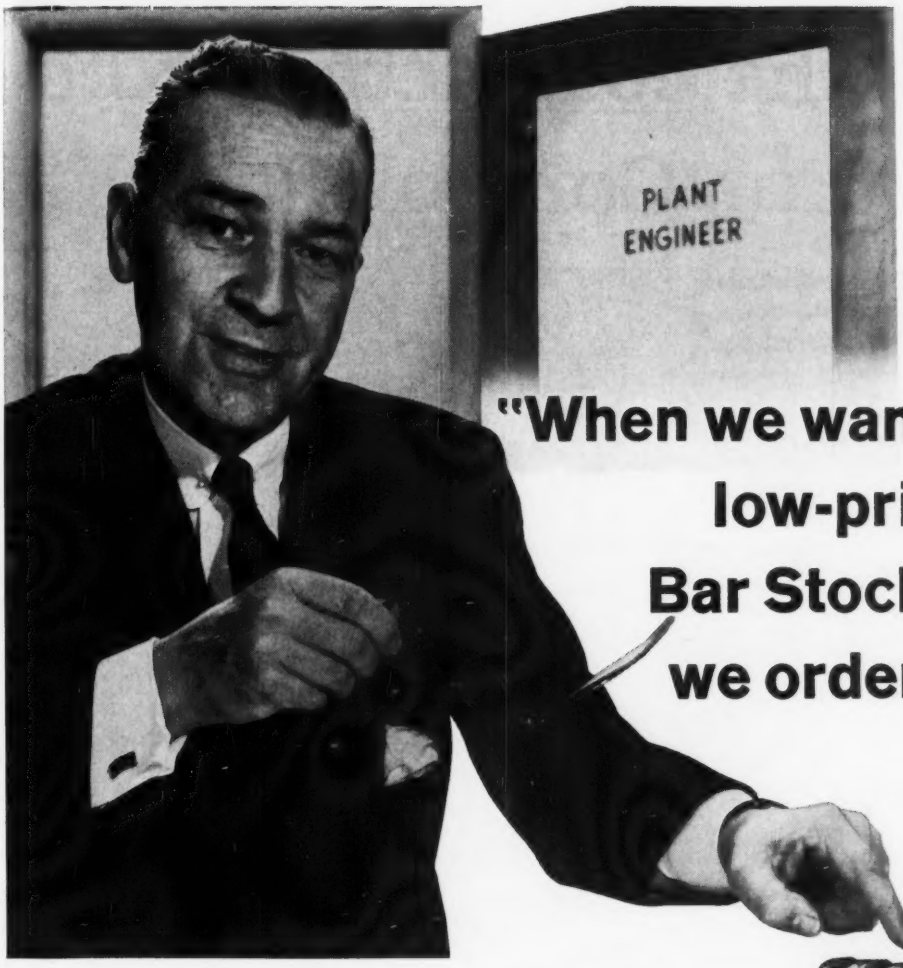

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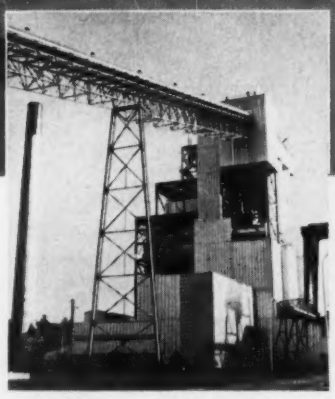

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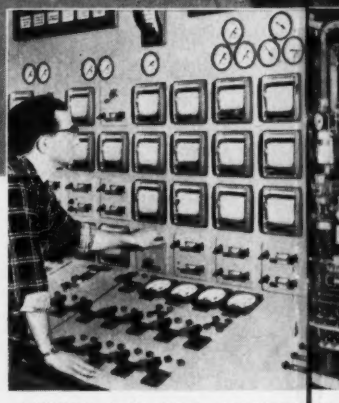

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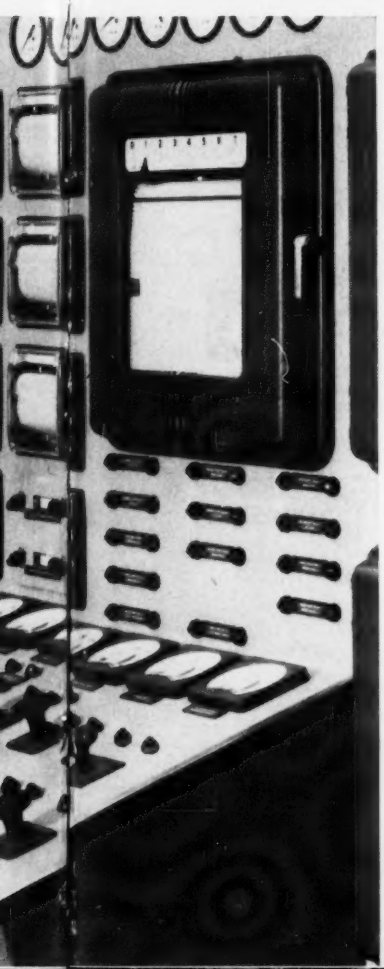

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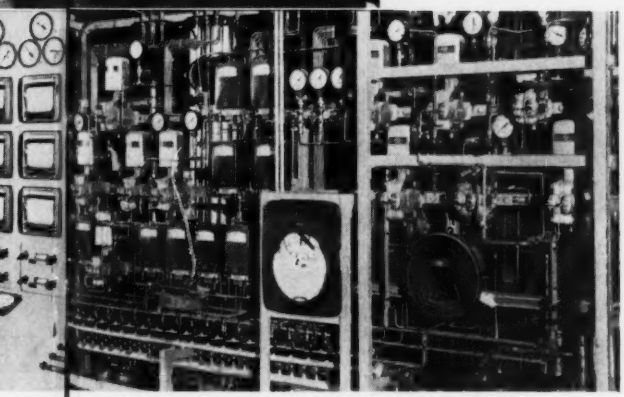

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LOUIS N ROWLEY, EDITOR • FEBRUARY 1961 • ESTABLISHED 1882 **Power**

Realistic circuit-breaker standards?

Anyone who has given even cursory consideration to standardization is aware of the enormous benefits that flow from sound industry standards. And anyone who has worked on the development of such standards knows what a demanding task it can be, particularly to take proper account of all the interests involved.

The present problem faced by the Subcommittee on Power Circuit Breakers of the American Institute of Electrical Engineers is a case in point. For a number of years, working groups of the Subcommittee have been aiming toward a revision of several ASA Standards covering rating, testing and application of ac power circuit breakers. Revision proposals were presented at AIEE's 1960 Winter General Meeting.

At that meeting and since, industrial electrical engineers have expressed concern about the portions of the application standard dealing with short-circuit calculations. At the risk of dealing too briefly with a complex subject, the nub of the matter might be said to be the introduction of system resistance, previously neglected because it is small in relation to system reactance.

In theory, this refinement can be defended as leading to more accurate breaker ratings and more precise application. But for the typical industrial electrical system, obtaining significant data on the resistance of the components and solving the resistance network presents a formidable task. And unless the system resistance is determined with a high degree of accuracy, its inclusion in the short-circuit calculations may well cause a false sense of security, an apparent precision that does not in fact exist.

Why, it might be asked, cannot industrials continue using the familiar method based only on system reactance, purchasing breakers just as they have been doing for years? This, of course, would negate the very idea of a standard, which visualizes universal acceptance and use. But there is a practical consideration, as well. Breakers selected on the old basis would not be "standard" and this might well cause insurance problems, both with respect to premiums and to claims covering damage resulting from electrical faults.

There is no doubt that the proposed revisions of the circuit-breaker standards represent improvements in many respects and that they may be applied with success in utility systems. There is some doubt, however, whether the refinements proposed can, in practice, produce real improvements in industrial electrical systems. On the other hand, experience indicates that the present methods have been generally adequate in terms of actual results and that they are realistic in the demands they make for system data and calculation time.

The pros and cons of this question have been partially explored in several POWER articles (April 1960, p 101; Jan 1961, pp 64-66). Because of its importance to engineers concerned with industrial energy systems, we intend to examine it in further articles now in the planning stage. And we are confident that the Subcommittee on Power Circuit Breakers will give a full hearing to all sides, looking toward final standards that give due weight to the interests and problems of all classes of breaker users.

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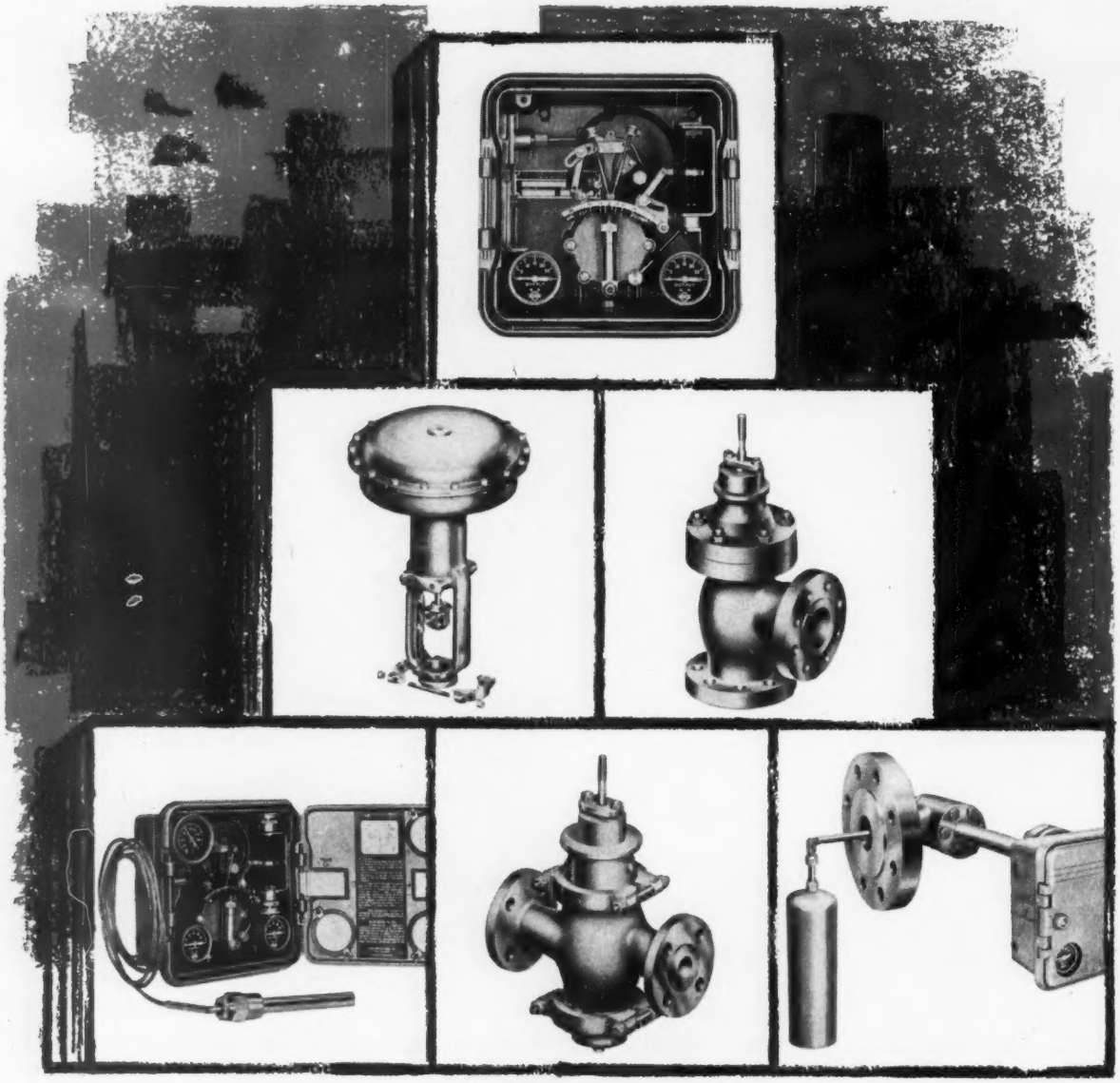

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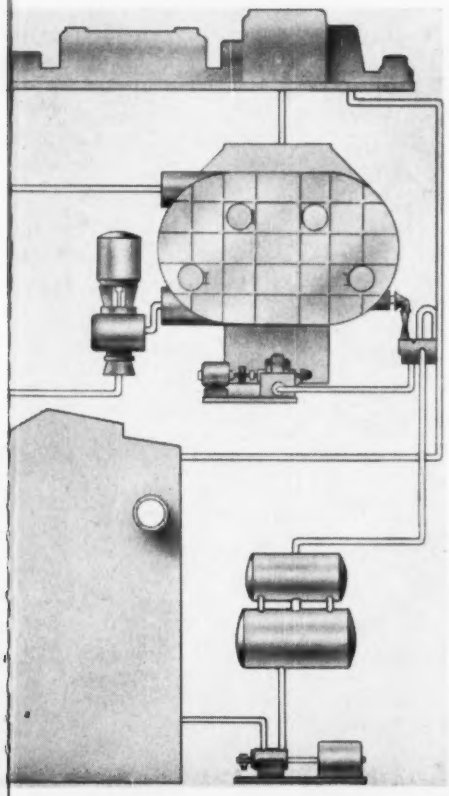
B G A SKROTZKI
Associate Editor in Charge

a Today's Development report

How much plant automation? A problem of control philosophy

- Fully automatic central stations are coming into operation. Along with these new systems come new problems in control for you to answer
- How many plant auxiliaries—boiler-feed pumps, condensers, circulating-water systems—should be automated and how will it be done?
- How completely should these auxiliaries be automated in a controlled plant of the future?
- What equipment factors are important to operating safety or unit performance?
- Here is a guide to the planning you must complete today to prepare for system design and equipment selection for tomorrow's fully automatic plant



Current trend toward full automation of utility steam-generation plants has compressed several years of system analysis and development into a period of months. This has exposed weak points in automation philosophy and forced parallel development of basic automation concepts and final control systems.

The two major components of a steam plant, boiler and turbine-generator, are already recognized as needing fully automatic controls; they now possess the most complete control systems in the plant. But complete automation of a plant involves many auxiliary units, including the so-called "fluid-handling" group shown at left. In these areas some questions still remain: Which items shall we automate? How shall we automate them? What equipment factors are important to operating safety or unit performance?

To help you plan effectively for future steam-plant automation, let's trace through an automation philosophy as it applies to the fluid-handling group. Author of this philosophy: Igor Karassik of

Worthington Corporation, recognized expert in design and operation of pumps. Combined with his basic analysis of controls, a summary of the current automation thinking of utility and consulting engineers will help you understand better present trends and future needs in total plant automation.

Based on our survey results, one part of the unit cycle, the boiler-feed pump, gets a thorough going-over to determine automation philosophy and how it was arrived at. This is not a textbook of hardware details but a guide to that very-important first step in plant automation: determining what to control, and what degree of control the equipment requires for full automation.

Auxiliary automation calls for analysis of control philosophy plus detailed breakdown of auxiliary functions

By I J KARASSIK, Consulting Engineer, Worthington Corporation, Harrison Div

Any engineer embarking on the design of a completely automatic plant has his work cut out for him. With the exception of that ultimate in automatic plants, the unattended unit, this engineer must constantly weigh the cost of each additional increment of automation against his one major standard: cost per kwhr.

There are three areas for steam-power-plant designers to cover in their search for reductions in kwhr cost: (1) Lower initial plant cost per kw through larger-size units and plants, simplified plant structures and elimination of excess spare equipment. (2) Lower operating cost through higher temperatures and pressures and more-sophisticated heat cycles. (3) Lower maintenance cost through greater reliability of equipment, better materials and more-thorough education of operating and maintenance personnel.

The past decade has produced many advances in these areas. But, while average reduction runs about 3% per year in fuel consumption per kwhr, there is mounting evidence that this rate of improvement will drop to 2% and even 1% over the coming 20 years. Also, reduction in first cost resulting from installation of bigger units may no longer be available to us now that we've reached unit sizes of 500 mw.

We have every reason to think, therefore, that our greatest chance for improvement lies in eliminating some spare equipment and reducing maintenance costs. Both spare equipment and maintenance are intimately connected with greater reliability, and properly applied automation can improve reliability.

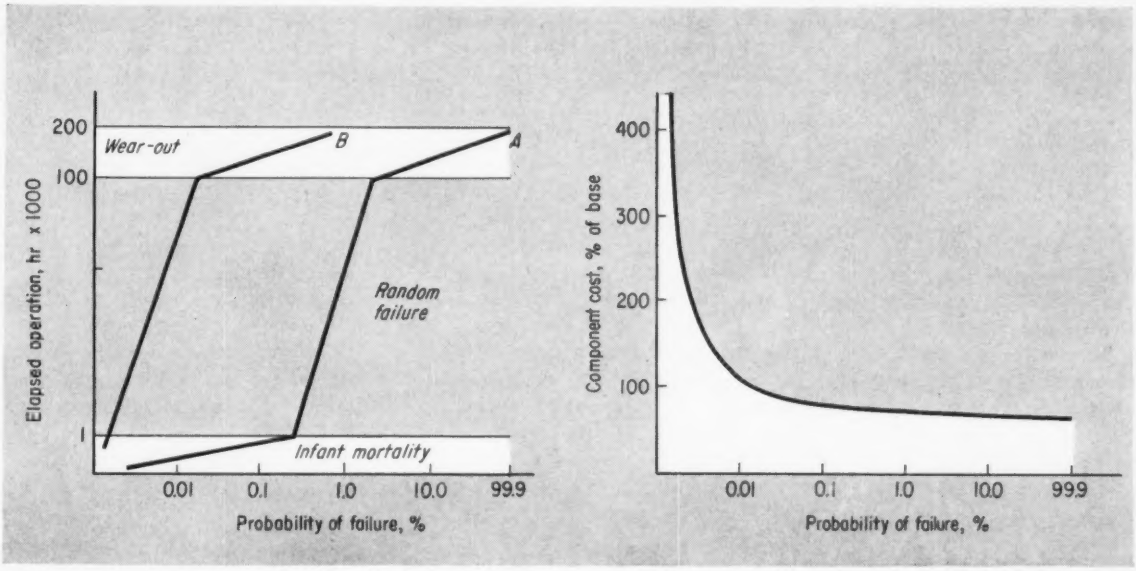
When we talk of reliability we are inevitably forced to examine the other side of that coin—probability of failure. A typical plot of equipment failure vs elapsed operating hours appears above, right. For classification, we have broken failures into three areas: (1) Infant-mortality failures which occur in early stages of operation and can be traced to faulty components, installation or initial operating procedures. (2) Random failures which indicate a situation that could be classified as "out of control." (3) Wear-out which can be normal if operating hours approach expected or designed life of the components. Curve *B* approximates results you might get if automation reduced failures caused by improper operation, sudden load shocks or improper installation.

Automation wields most influence in the infant-failure range, also decreases probability of random failures resulting from repeated load shocks during operation. Thus we can evaluate equipment automation through cost of reliability. Automation may be considered added cost resulting from attempts to reduce equipment failures. By assigning a cost figure to failure we can balance cost of automation against the cost of a failure which could have been prevented.

Another important factor involves the law of diminishing returns. The first few increments of increased investment in equipment quality or control produce a marked reduction in probability of failure. But successive increments produce less reduction in equipment failures. A representative curve of equipment investment vs probability of failure, above right, indicates the narrow range of economical improvement available to the designer. If he errs on the low side of optimum investment, probability of failure increases markedly; overinvestment in automation produces no measurable decrease in failures.

On the basis of these estimated reliability figures plus the often-used criteria of optimized performance we can evaluate each added step toward full plant automation. Now we must analyze each component of the plant to

Increased equipment reliability helps justify automation



RELIABILITY INDEX may be affected by equipment automation. Failure curve *B* results from safer startup, fewer operating shocks.

Cost of automation must be balanced against cost of failure which may result from equipment operating without the added protection

determine what must be controlled and how to do it.

Basic objectives of controls are to start, stop and continuously operate a system at optimum efficiency under the safest conditions. Controls can be classified by function as operational or supervisory. To achieve our objectives, controls must measure, evaluate measurements and initiate sequential or corrective action in the light of these evaluations. Obviously, we'd want these duties from any control system. The difference lies in the magnitude of total control applied to a plant. We may be concerned with control of a boiler-feed pump, but we must analyze each control function from the point of its effect on operation of the complete system.

Of course, complete automation will not necessarily come suddenly and immediately to all new steam-power plants. It will more-likely be a step-by-step process in which certain functions presently filled by operators will be turned over to automated controls.

After thorough analysis you may decide to go in the direction of full plant automation, which usually means automatic start and stop plus limited operating control by computer. But you still are faced with many decisions concerning degree of automation for plant auxiliary equipment or components of the fluid-handling group. For instance, we do not absolutely need to know at all times the hydraulic performance of boiler-feed pumps. We can, instead, establish certain acceptable limits of deterioration beyond which operators will be alerted to the need for remedial maintenance.

In preparing an analysis of system components it is best to list every possible item concerning a component which may affect your decision about its operation. This even includes items remote from the equipment in question. Strictly speaking, measuring pressure differentials across check and gate valves or across a feedwater regulator and monitoring the position of these valves might be considered outside the realm of boiler-feed-pump automation. Nevertheless, information on these items generally will be necessary to your pump-control decision-making. In addition to operational controls, you'll have to think in terms of supervisory controls —to protect the mechanical integrity of an unattended pump, for example.

It is rather strange that equipment such as the boiler-feed pump has stirred up so little interest in the line of supervisory control. The only exceptions are protection against excessive temperature rise at low flows and the use of motor-driven auxiliary oil pumps to prevent operation with insufficient oil pressure to the bearings.

Besides low flows and inadequate lube-oil pressures, there are several circumstances which could interfere with the satisfactory operation of a boiler-feed pump: insufficient npsh or condensate injection for sealing; excessive oil temperature, bearing temperature, vibration, shaft runout or axial thrust; improper axial rotor positioning; excessive misalignment; inadequate warm-up. Many devices are now available to supervise these particular maladjustments. Our problem, however, is more fundamental than the choice of sensing devices. We must decide what to do with the impulses we obtain from these devices.

Sensing-device impulses can be indicated, logged, made to actuate an alarm annunciator or—and this is the most important function in my estimation—the impulse can initiate corrective action. It can shut down a pump or prevent it from starting if certain prerequisite conditions are not met.

I have outlined briefly what can be done in the way

These six questions helped sample utility-industry opinion on automation

Have you and your company started work on full steam-power-plant automation? How far has your planning gone?	Do you consider that b-f and circulating pumps, condensers, air-removal equipment must be fully automated?	As a partial step, would you consider automatic pump start-stop as dictated by character of the load?
No, we have studied performance monitoring but have not embarked on a full plant-automation program	*We do not consider that b-f pumps must be automated. We do think cooling towers should be automated*	*If properly annunciated, we would consider automatic start-stop as dictated by load characteristics*
We have not started detail design of full steam-plant automation; we have engineered monitor systems	*We don't consider that auxiliary equipment must be fully automated unless overall costs are reduced*	*Presently extra pumps come on as discharge pressure drops, so automation for load should be simple*
We have not started any active work on automation of our steam-power plants, have thought out our aims	*I do not believe that fluid-handling equipment need be fully automated unless unit is unattended*	*I do feel automatic starting and stopping is practical, assuming complete, automatic monitoring*
We have not started work on a plant that would start up and shut down automatically. It wouldn't pay	*To achieve full automation on a startup or shutdown, all these items should be automated*	*Automatic starting and stopping to handle normal load changes would not be advisable*
No, computer control's high cost, limitations of sensing elements and other items will delay our use	*Yes, either fully automated or with remote startup and shutdown with a single switch for each component*	*No, we are considering single full-capacity pumps and stocking spares to protect against lengthy outages*
We have assembled data for a symposium on the subject. There are several schools of thought here	*I feel b-f pumps, condensers, circulating pumps, air-removal equipment should be automated*	*Yes, automatic starting and stopping of boiler-feed pumps and condensate pumps would be considered*
We have given little consideration to full steam-plant automation, but auto start-stop seems logical step	*When automatic start is provided it will be necessary to bring all of these components into the system*	*We provide new units with one full-sized condensate pump, so automatic startup is not really needed*
We have not considered full automation but may apply some of the features in a partial program	*For plants we consider, I do not feel that feed pumps, condensers, etc need to be fully automated*	*In a plant designed for peaking services or wide load swings we would consider automatic starting*
We are outlining approaches for automatic programing of turbines, auxiliaries. Coal firing comes later	*Yes—in fact we have these concepts in manual switches now, and feel we can do it with a computer also*	*Yes, we have this concept incorporated on one of our latest units for turbine and motor-drive pumps*

of control of the fluid-handling group. Before attempting to follow my philosophy through for a specific component, I would like to compare—in the tables above—the philosophy of several consultants and utility engineers from all parts of this country with respect to possible degrees of automation they are ready to embrace.

To sample their opinion in this area I asked the six questions listed above. The number of replies should not be considered totally representative of industry plans, and the six questions do not include all possible degrees of automation. I merely offer this tabulation, without comment, as a rough sample of current thinking on automating auxiliaries.

Results indicate hesistancy to embrace full automation at this time. Detailed explanations listed above confirm reliability as an important factor in cost evaluation, indicate that many system engineers have not yet reached the point of accepting full automation as a guarantee of improved reliability. Plotted in bar-chart form the answers indicate degree of automation in current plans.

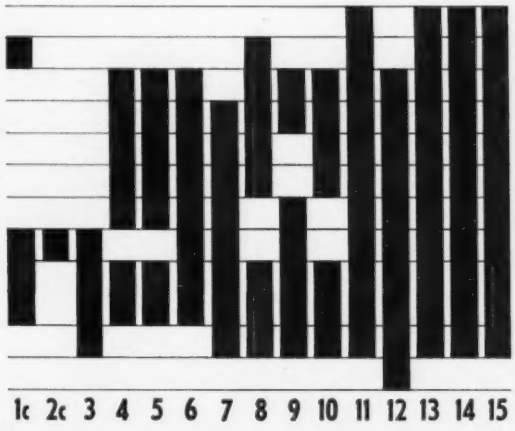
At the time of my survey few utilities were planning or designing fully automatic plants. However, several of them either plan or already have automated sub-loops for components of the fluid-handling group. Obviously, experience gained from sub-loop automation will be utilized in subsequent designs for full automation. But at this moment none of the engineers has adopted the concept of the unattended plant.

With these results in mind we'll follow through, on the last page of this article, evolution of a control philosophy for a specific portion of the fluid-handling group—the boiler-feed pump. By laying out a similar study plan for your unit conditions, you can arrive at your own considered answers to my original six questions.

of the fluid-handling group. Here are condensed answers, plus . . .

Would you like pumps monitored for shaft eccentricity, casing Δt? Are there any other items you would list?	Would you monitor pump performance by continuous measurement of capacity, press., temp, speed, power?	Do you have any comments or suggestions to make in regard to this overall problem of power-plant automation?
Yes, we would like to see all these items monitored. We assume pre-start requisites would be monitored	*We feel frequent, comprehensive spot checks would suffice. Pump performance doesn't change rapidly*	*Automation of b-f pumps should be approached carefully. The other auxiliaries are automated readily*
We consider equipment manufacturers to be in a better position to evaluate monitoring requirements	*Hydraulic performance is monitored currently. Instruments monitor capacity, pressures, temperatures*	*Automation is expected to supplement operator's ability, but must be more reliable than the operator*
I believe you have covered the basic items. These conditions must be met within established limits	*Pump-performance monitoring is a further refinement which can come later in development of automation*	*I feel certain the present level of automation technology is more than adequate to cover any needs*
I believe monitoring of all these items to be beneficial. Could a simple vibration sensor do the job?	*Pump-performance monitoring is intriguing, but hardly justified in any but very-large installations*	*I believe full automation will see extensive use within ten years. We need systems we can trust*
No, we would prefer that b-f pumps be built sufficiently rugged that such monitoring would be unneeded	*No, we feel that periodic tests are sufficient; a logical correlary of the answer to question 4*	*We feel system simplification, sub-loop and sensing-element development must precede full automation*
Large units make it imperative that vital auxiliaries be fully monitored regardless of auto-plants	*My first reaction is "no," but for larger-sized units periodic checking of these items may be justified*	*I believe automation should be handled as another tool available to provide safe, efficient power*
We feel only minimum monitoring, such as lube-oil pressure, bearing temperature, is needed for pumps	*I see little benefit in measuring continuous efficiency of boiler-feed pumps. Check delivery pressure*	*I think it would be wise for manufacturers to survey their own equipment for control and data points*
I do not believe monitoring items beyond bearings, oil, suction and discharge pressures is needed	*We could not justify cost of continuous monitoring. Periodic checks should be adequate indications*	*I believe the most fertile field for automation is boilers, with cooling-tower fans the next area*
These features would be desirable for full-capacity or two half-capacity pumps and automatic programs	*This might have possibilities for future full-capacity pumps, but why not incorporate in unit monitor?*	*Encourage designers to stress simplicity, fail-safe designs to eliminate use of excessive hardware*

. . . a picture of how much automation the utilities want now



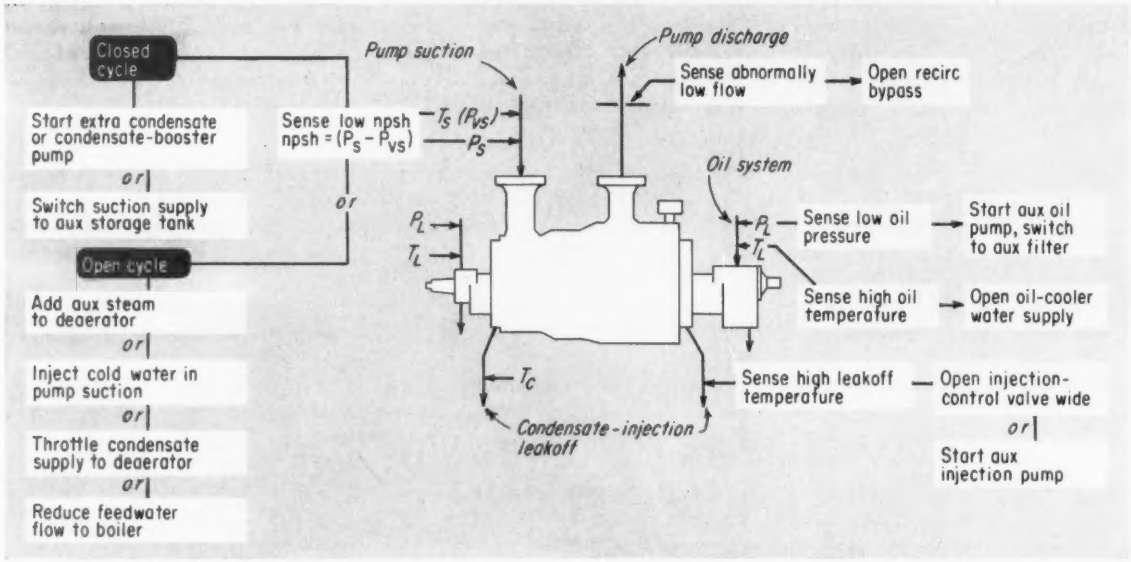
ll automation, designing
ll automation, studying
x automation, b-f pump
x automation, condensate pump
x automation, circulating pump
x automation, air-removal equip.
tomatic start, b-f pump
tomatic start, condensate pump
fety monitor, pump vibration, shaft eccentricity or runout
fety monitor, casing Δt
mp-performance calculation

Detailed answers to the six questions appear at left in the form of "yes" or "no" answers to a series of steps in plant automation. Black spaces represent "yes" answers and bar length suggests degree of automation desired. Vertical bars marked by subscript *c* indicate replies by consulting firms. "No" answers do not necessarily represent blind spots in automation. They indicate that for a specific operating situation cost is too high.

Limited number of automation steps represented by the bar chart concentrate on the fluid-handling group. A series could be assembled for other auxiliary groups.

continued

Now, let's develop our own automation philosophy for one component



CORRECTIVE CONTROL as well as operational and interlock systems may be developed from logic plans. Malfunctions are listed and required measurements selected. Sensor signals must initiate action—represented by one of control boxes shown above

Now let's put information from the preceding pages to use in analyzing automation of a boiler-feed pump. To begin with, I assume the plant will incorporate automatic startup, shutdown and load modulation. My control system must integrate operation of the boiler-feed pumps into the overall plant automation, and supervise pump operation to preserve equipment's mechanical integrity.

Operational control of boiler-feed pumps would include modulating pump load as demanded by plant requirements and starting or stopping pumps as plant load fluctuates. I must list operating variables which affect pump load, quantities which must be measured or sensed and control means available to change pump load.

All modern power plants boast modulating control of boiler-feed-pump load by control-valve or pump-speed-control system. Start or stop functions are not as often automated, but must be for fully automatic operation. One of several plant variables can be used to determine how many pumps should be operating. Logical choices: station load or total feedwater flow to boiler. With operational controls available, we must monitor the unattended pump. This is a job for supervisory controls.

Supervisory controls may be classified by function into three groupings: controls for (1) corrective action (2) pump shutdown (3) preventing startup.

Corrective-action example is the system logic diagram, above. Diagram includes monitors of condensate-injection sealing-water flow. Effectiveness of sealing responds to several variables, including injection pressures, temperatures or flows at both ends of the pump, injection leakoff temperatures or flows at both ends.

But we need not use all these variables. Leakoff temperatures can be used; other variables can be logged and available for print-out, but aren't necessary for control.

Pump flashing is another important field for corrective control. Some boiler-feed pumps can operate in a flashed condition with an excellent chance of coming through unscathed, and this transient condition may be relatively short, but controls are still preferable.

Other corrective actions should be analyzed in the same way. My own opinion: all five corrective controls shown above deserve to be incorporated.

Shutdown or startup prevention controls are somewhat different. Some variables in an automated plant must be monitored while others may be classed as luxuries. Let's analyze some of these items for importance:

(1) Vibration of the rotor must be monitored; it is a key factor in judging general behavior of the pump.

(2) Shaft runout or eccentricity could be monitored to determine shaft warpage or other damage, but few plant designers will incorporate this control.

(3) Shaft axial position could be measured relative to the thrust bearing. This would indicate the axial opening between the balancing-device faces. But again, incorporation of this monitor would be rare.

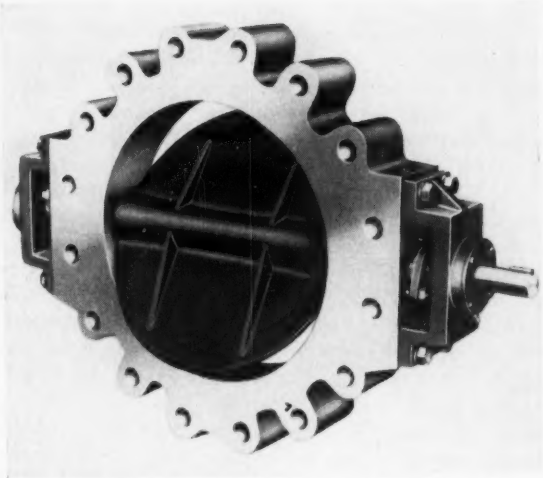
(4) Lube-oil pressures probably are already monitored on all h-p boiler-feed pumps. They're a must here.

(5) Unbalanced axial thrust carried by the thrust bearing could be monitored, but monitors are complex, expensive. Instead, use thrust-bearing oil temperatures.

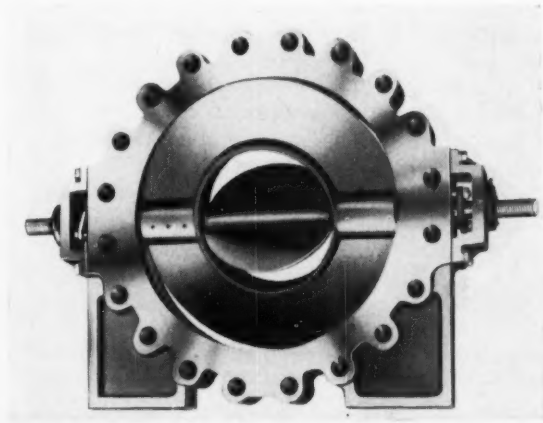
(6) Misalignment of pump and driver can cause wear, vibration and even failure, but measurement is difficult and we monitor effect rather than the cause.

I can conclude that of the variables mentioned, only lube-oil pressures and temperatures and vibration require monitoring, with the possible exception of shaft runout.

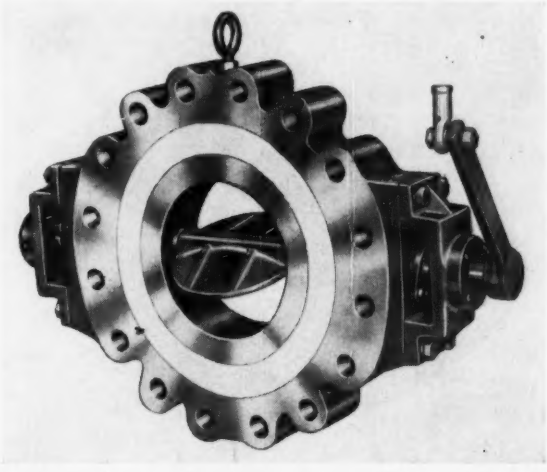
We started out looking at the forest of plant automation and end with an examination of one tree. We now know what we are willing to pay for automation and what is required for full plant automation. Only after this dual analysis can we make a reasonable start at laying out a control system and selecting hardware.



STANDARD BUTTERFLY VALVE has equal percentage flow vs valve travel characteristic. This helps in control applications



DOUBLE DISK VALVE gives wide control range. When flow is too low for large disk to control, inner disk does all the work



HIGH-TEMPERATURE VALVE has refractory lining to isolate heat from valve working parts—bearings, stem packing, seals

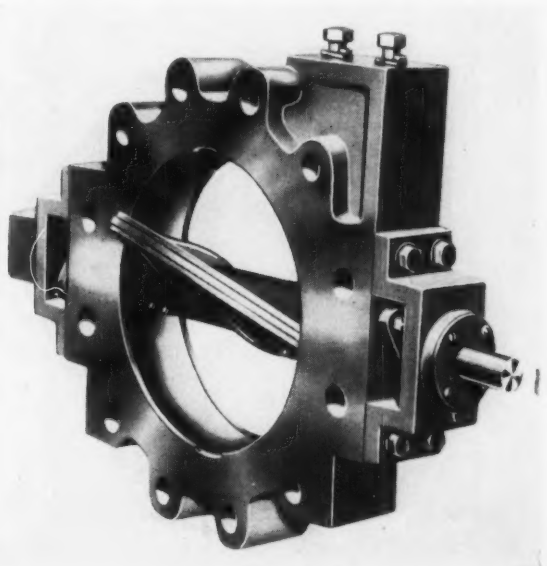
Attractive hydraulic and mechanical characteristics boost butterflies as final control elements in many energy systems. Here's a roundup on the advantages of . . .

Butterfly valves

By I C GREGG, Continental Equipment Co
Div of Fisher Governor Co, Coraopolis, Pa.

Butterfly valves have been with us a long time—some of the first valves in recorded history were butterflies. But until recently they were relegated to relatively light duties—duct dampers and automobile carburetor throttles. Now, however, recognition of their many advantages is growing; as a result their use is increasing in many energy fields. A breakthrough came when leak-tight butterfly valves were developed. In the control area their special characteristics and advantages are becoming more commonly recognized.

Some advantages of butterfly valves have caught the eye of energy-systems designers: (1) reduced cost, weight and space needs (2) operating flexibility (3) no need



PISTON RING in valve disk provides low leakage where resilient seat can't be used because of temperature or liquid handled

for separate support (4) special hydraulic characteristics and (5) reduced maintenance.

Let's take a look at butterfly-valve construction. What types are available? What special designs can meet severe operating and control problems?

Standard butterfly-valve design, p 69, can be modified to include a resilient seat for tight shutoff. Or where high temperatures or liquid properties rule out this seat type, valve disk can be fitted with a piston ring to minimize leakage. For very high temperatures, refractory-lined valves limit heat transmission to operating parts. Outboard roller bearings on each valve-stem end are isolated from the liquid pumped, and carrying the stem all the way through the valve body assures maximum rigidity, cuts out binding and jamming. Various combinations of these heavy-duty features permit applying butterfly valves as final control elements in temperature ranges of −300 to +1800 F at pressures up to 3000 psig, inlet and control differentials to 300 psi.

Pressure-drop characteristics make the butterfly essentially an equal-percentage valve—a change in valve travel will result in an equal percentage of change in flow. Considered only in the light of change in open area for equal changes in valve travel (and this is recognized as not being an equal-percentage function), curve below does not appear justified. But approach velocity and diverting action of the disk are both functions of disk position. And they combine with area function to influence shape of the flow-characteristic curve and make it an equal-percentage curve.

Maximum turndown recommended for most butterfly valves is about 10 to 1. To get good control beyond this point a bypass of some sort should be used. Or, as is often done with larger valves, a small port can be built into the larger disk. Separate operating devices control these two concentric valve disks. Reduced port diameters can be built into line-sized butterfly valves to avoid operating too near the closed position.

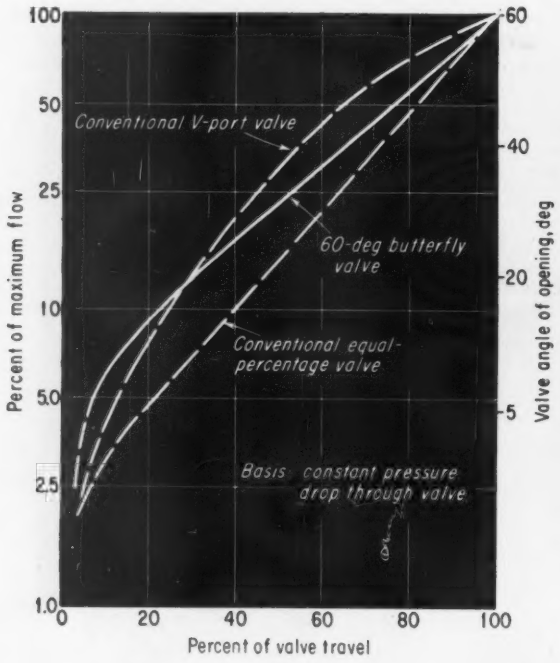
Normal maximum opening of butterfly valves is about 60 deg. This limitation lies in the valve design itself. Valve is basically designed around its main shaft, and shaft diameter is determined by the operating-torque requirement imposed by fluid-dynamic torque loads on the disk it supports. Minimum disk thickness is then established by diameter of shaft passing through it and the metal section of the disk required to support the load.

Since disk thickness determines maximum open area available through the valve, restriction increases in proportion to the pressure drop for which the valve is designed. When the valve is close to full open, disk's wings begin to disappear into the profile of its center section. So at some angle less than 90-deg open, valve reaches its limiting variable area and no increase in open area results from further rotation of the valve stem.

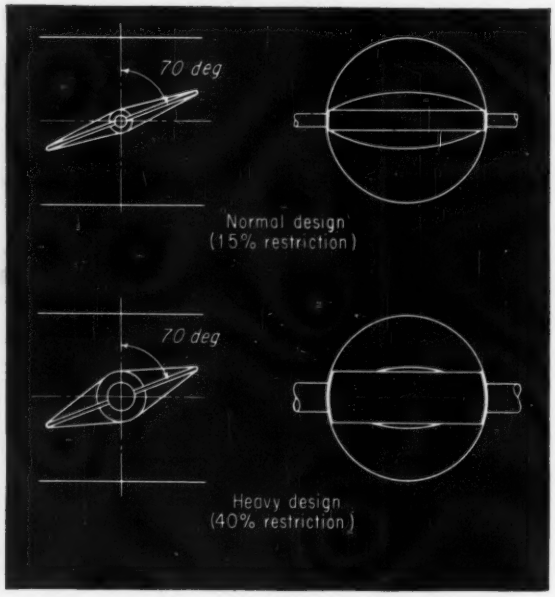
Butterfly valves are ideally suited to control applications needing minimum pressure drops. Their low wide-open losses are a great help here.

Operating torque needed to position a butterfly-valve disk is really the sum of two torques—unbalanced hydraulic torque and static valve torque. Unbalanced hydraulic torque tending to close the valve is an emperical function of the disk position, pressure drop and the cube of the disk diameter. Static torque is the friction in the mechanism of the valve itself—bearings, packing

EQUAL-PERCENTAGE hydraulic characteristic of butterfly valves compared on pressure-drop basis to other control valves



OPEN VALVE AREA is limited by profile of valve stem and disk thickness. This usually occurs at 60- to 70-deg open position



and seals—and is proportional to the pressure drop.

Unbalanced hydraulic torque tends to close the valve; static torque can be in either direction, closing or opening. So operating torque needed to open a butterfly valve is the sum of hydraulic and static torque; torque to close the valve is the difference between the two.

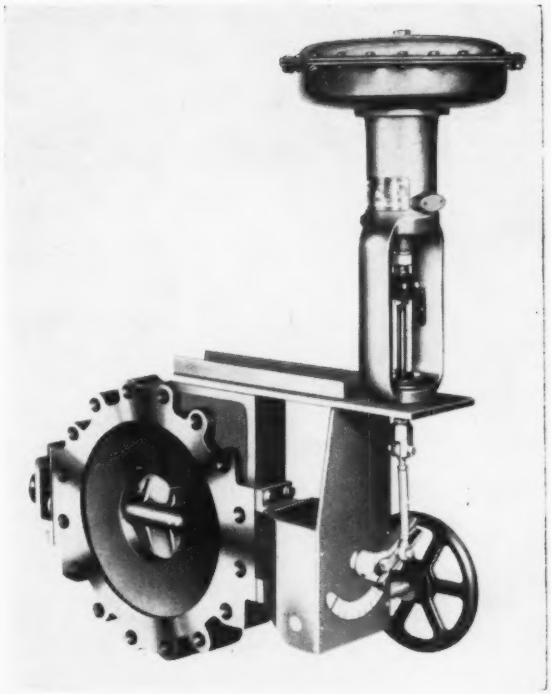
Since both unbalanced hydraulic and static torque are proportional to the pressure drop, disk-shaft diameter must be increased to meet increased pressure drops. Butterfly valves are not balanced, so static pressure drop across the surface and impact of the fluid produce a thrust load on the disk tending to carry it downstream. And this load is not evenly distributed on the disk except at fully closed and fully open positions. At all intermediate positions thrust load on the upstream wing of the disk is greater than load on the downstream wing.

Let's calculate shaft torque resulting from a pressure drop of five psi across a 24-in. butterfly valve. Curve, right, shows required torque per unit-pressure drop; find actual operating torque by multiplying unit torque at a given disk angle by corresponding pressure drop. Example: with the disk opening to the 60-deg position, curve shows that the torque is 6500 in.-lb per psi drop across the valve. So the product of unit torque and pressure drop is 32,500 in.-lb (5 psi $\times$ 6500 in.-lb per psi = 32,500 in.-lb).

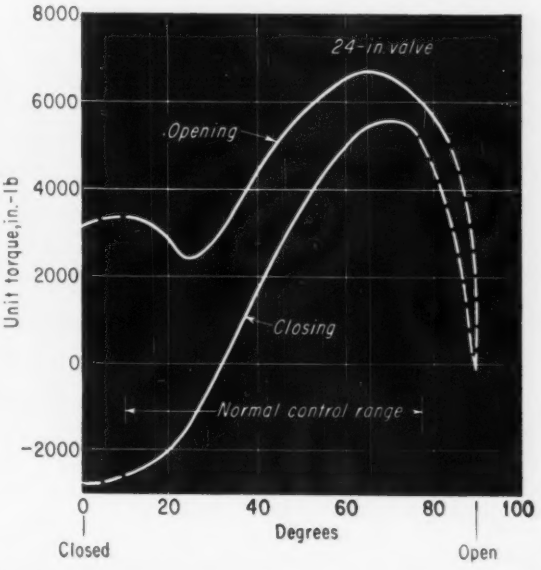
Maximum operating torque may not always be at the position corresponding to maximum flow; it's seldom at the maximum-unit-torque position on the curve. In our example the maximum unit value occurs at 65 deg when opening. But it's evident that as ratio of pressure differential across the closed valve to differential at maximum flow increases, valve position corresponding to maximum operating torque will occur nearer to—or perhaps at—the fully closed position. In our case, any shutoff differential over 11 psi will cause maximum operating torque to occur in that position.

Actuators for butterfly valves are available to meet almost every application. In selecting them remember that both diaphragm or piston areas and travel are important. Force exerted on the valve stem is a function of diaphragm or piston force (an area function) and valve-lever length (a function of actuator-stem travel and the desired angular movement of the valve stem). Generally it's best to use an actuating device with as long a stroke as can be conveniently mounted on the valve body. This reduces overhung load on the valve stem and lost motion in the actuator linkage. Be sure operating torque available from the actuator is sufficient to overcome maximum torque required by the valve *in any position.*

Advantages of butterfly valves in energy systems are many, but of course they must be checked against other valve types for each specific application. There is no doubt that butterfly-valve use has increased in recent years and will increase even further as their particular advantages are more generally appreciated.



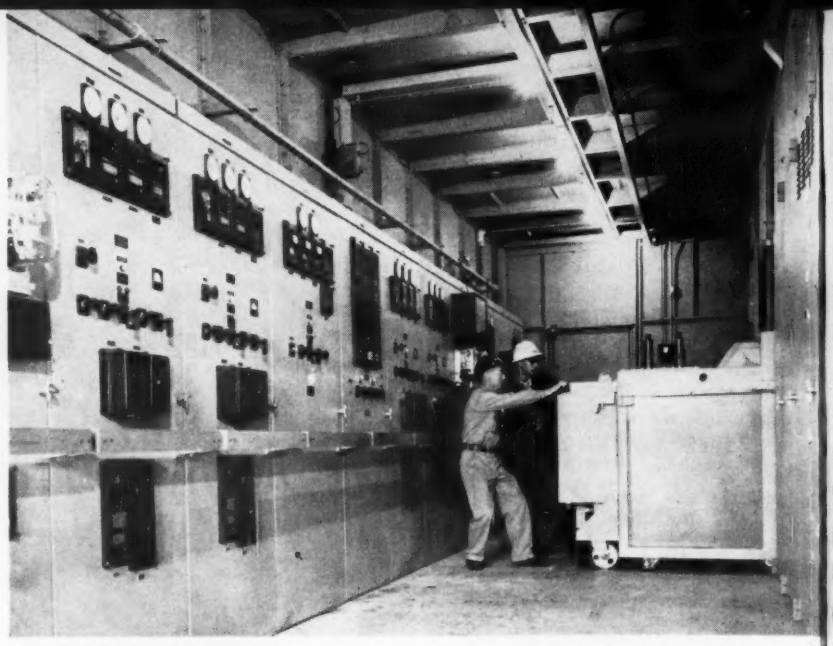
ACTUATORS to operate butterfly valves can be of any type. **But** be sure they have enough drive to operate the valve in any position



OPERATING TORQUE required to open and close a butterfly valve is the product of valve unit torque and the pressure drop

NO. 22: MAIN SUBSTATION SWITCHGEAR

Power to grow ...electrically



1200-AMP FEEDER BREAKER is maneuvered into place in protected-aisle substation. This is one of six feeder breakers which, with two main breakers, are 1000-mva interrupting

When electrical needs jump 150% in a decade, it takes sound PTG planning to keep production high and costs low. This plant did it by . . .

Shifting role of main-sub switchgear

During a 10-year growth spurt, Standard Oil of California's Richmond Refinery increased its electrical load requirements 40 mw —60% of total present load. New distribution system for the plant was designed with Power to grow . . . *electrically* in mind. It includes industry's first installation of 1000-mva metalclad switchgear with magnetic air breakers.

In 1948 a study of the refinery power system was initiated and a program for expanding it, based on projected required load, was developed. That survey was basis for an electrical-system updating that remained satisfactory until 1955. By then total load had increased to about 30 mw, with projected requirements for another 20 mw which were foreseen for the immediate future.

Purchased power at that time originated at a large Pacific Gas and Electric Co substation some two miles from the refinery. An ac network-analyzer-board study made by General Electric and Bechtel Corporation application engineers working with the refinery's systems engineers indicated that 65 mw was about the maximum total refinery load that could be handled from the existing Pacific Gas and Electric substation.

By 1958 it became apparent to the power company that it wasn't economical to supply power using the 12.5-kv circuits from the main substation two miles away. A joint study was begun to solve problems of supplying electricity through 110-kv lines brought to the center of the refinery. Cooperative recommendations by General Electric, Pacific Gas and Electric Company, Bechtel Corporation and Standard Oil engineers resulted in the present distribution system, shown in the 1-line diagram at right. Note division of ownership.

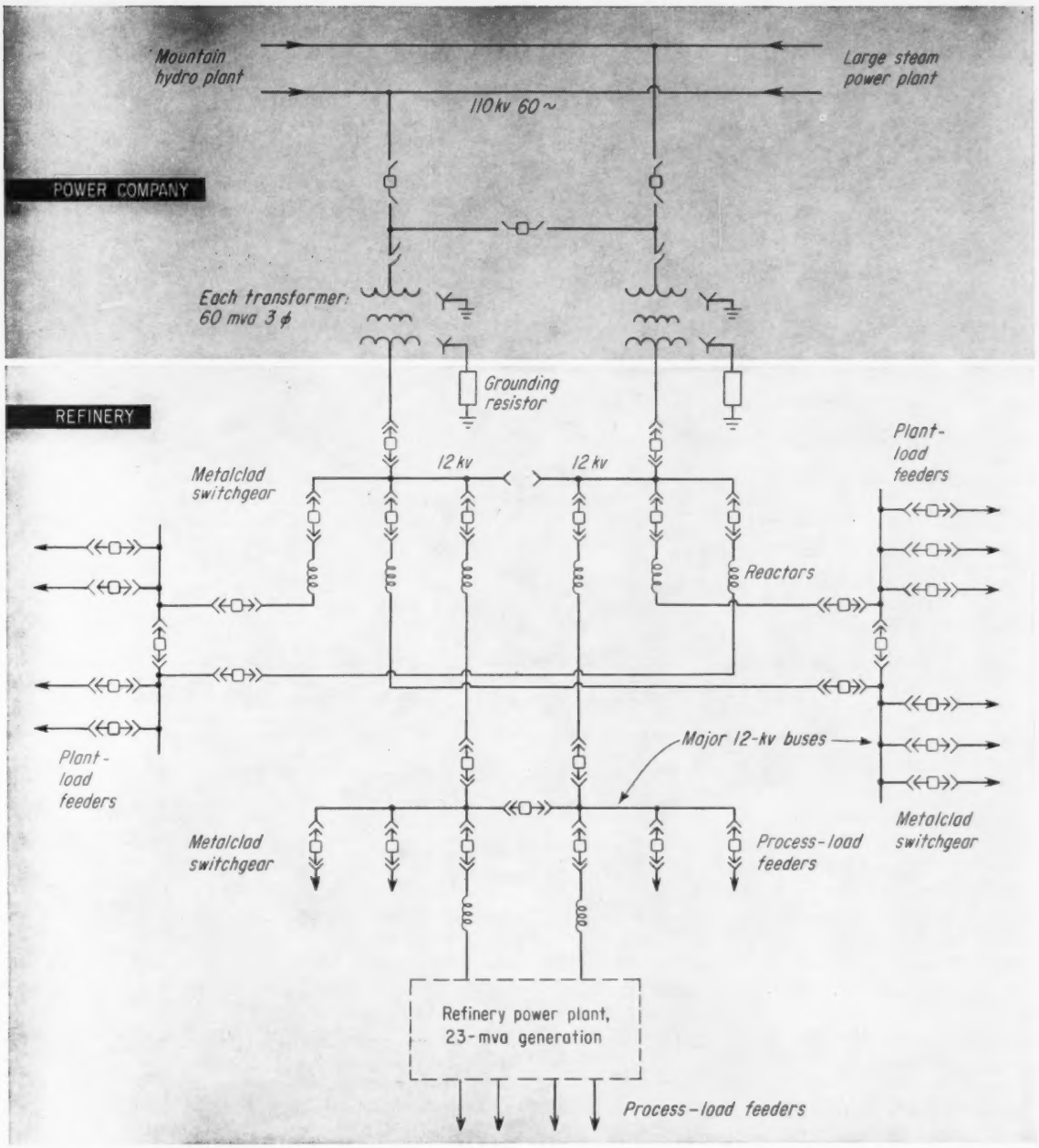
Refinery's main sub provides power for their 67-mw load in much the same way a utility distribution system operates. Maximum expected load: 100 mw; system components are rated in excess of this.

Power is furnished in bulk at 110 kv by the utility. Main sub steps it down to 12.5 kv and it's distributed at this voltage to area substations, which in turn step down to voltages suited to the immediate processes served. About 20 mw are produced by the refinery's own steam-generating plant.

Transformers are each rated 60-mva forced-oil-air cooled. H-v side is 117.5-kv maximum with four taps to 107.5 kv. Secondary maximum is 13.1 with ± 5% load-ratio control.

Protection on the high side of the transformers is provided by three 115-kv power oil circuit breakers. Two main 12.5-kv breakers are metalclad magnetic air units with continuous current rating of 3000 amp. When fan cooled, these breakers will continuously handle 3750 amp. Interrupting capacity is 1000 mva. Metal-enclosed bus duct runs between the main circuit breakers and the transformer throats.

Six feeder circuit breakers, distributing power to the area substations, are rated 1200-amp continuous



MAIN SUBSTATION and 12-kv utilization buses interconnect to give maximum service reliability and provide for system expansion

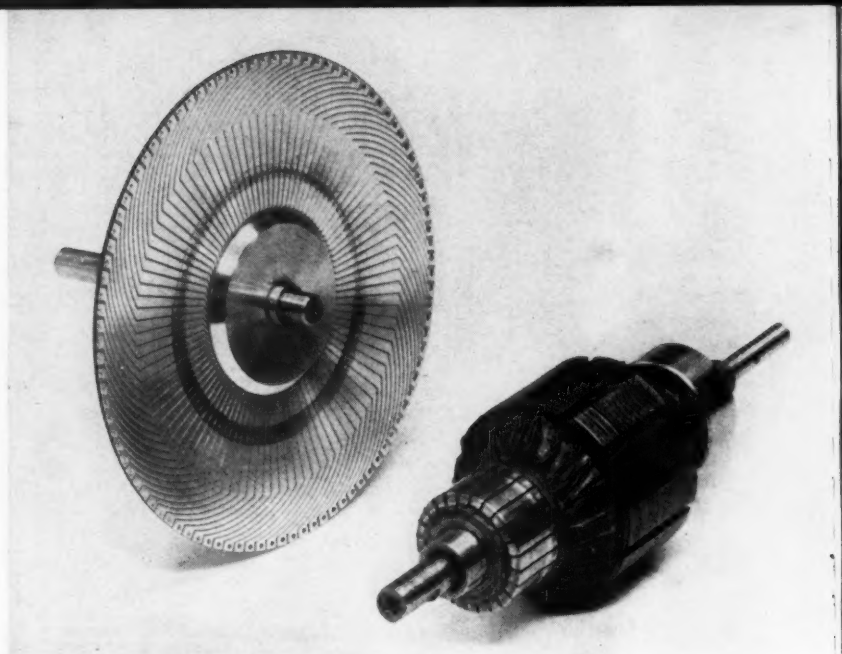
with an interrupting capacity of 1000 mva. To provide power to grow, additional 1200-amp feeders can be added to each end of the station. One of these will go in this year.

Protected-aisle design of substation gives maximum shelter for the eight circuit breakers and their associated equipment, permits easier maintenance whatever the weather, photo, above left. All circuit breakers are vertical-lift type and have stored-energy closing mechanisms for fast, efficient operation under all conditions. Another benefit: stored-energy closing minimizes control power requirements of the substation.

Reliability of system was an important consideration in its design, as the 1-line diagram shows. Two power-company lines are used. One runs 11 miles from a substation delivering power from nearby steam plants, the other 4 miles from a sub handling hydro power from the mountains. Arrangement of h-v breakers makes it possible to operate either or both transformers from either or both lines to insure dependable power.

All breakers operate normally closed; the two transformers and refinery generating plant share the load. Location of the circuit breakers makes it possible to isolate a fault quickly without interrupting power to critical process loads.

Radical new design of direct-current motor—printed-circuit armature, permanent-magnet field—now comes as direct-drive servo motor



PRINTED-CIRCUIT ARMATURE bears little resemblance to a conventional one of about the same power output. Single-turn "coils" serve also as commutator bars; wear is slight

Printed-circuit motors: how far

Printed circuits are a proved success in replacing complicated wiring of control and electronic devices. They're easier to produce, in many cases more rugged and less subject to defects. A few years ago two French engineers invented a dc motor with printed armature circuitry. A printed-circuit motor was subsequently introduced into the U.S. by Printed Motors, Inc, Glen Cove, N. Y. in association with other American companies.

Apart from the simplicity of a printed-circuit armature, these machines have characteristics different in many respects from conventional dc motors. These characteristics are pushing them into several specialized applications: machine-tool drives, tape-reel drives, positioning and velocity servos and others. All low-power jobs, of course. It's just too early to predict the future of printed-circuit motors, but an understanding of their basic design will help you keep an eye on their development.

Armature of printed-circuit motor is compared with conventional type of about the same rating in photo above. Features of printed-circuit design: relatively large diameter, very narrow "stack." Magnetic core is completely lacking; the metal hub provides mechanical strength only. Armature conductors are neither insulated wires nor bars; they're etched from the copper-coated insulation stock. Flat and smooth, the conductors serve as commutator bars, sketch next page.

Disk armature rotates in a circular air gap and cuts axial magnetic flux lines. The conventional dc armature rotates in a cylindrical air gap and cuts radial flux. Field flux in available motors is provided by permanent magnets, but a larger machine of the future could use electromagnetic field poles excited from external source.

Particular design illustrated has eight magnetic-pole faces, alternately N and S. From any pole face, magnetic flux passes through the armature, enters the rear soft-iron shunt plate, travels circumferentially in the iron, re-enters the armature, then passes to an adjacent pole face. Air gap is larger than conventional machine's, so relatively more magnetizing force is needed.

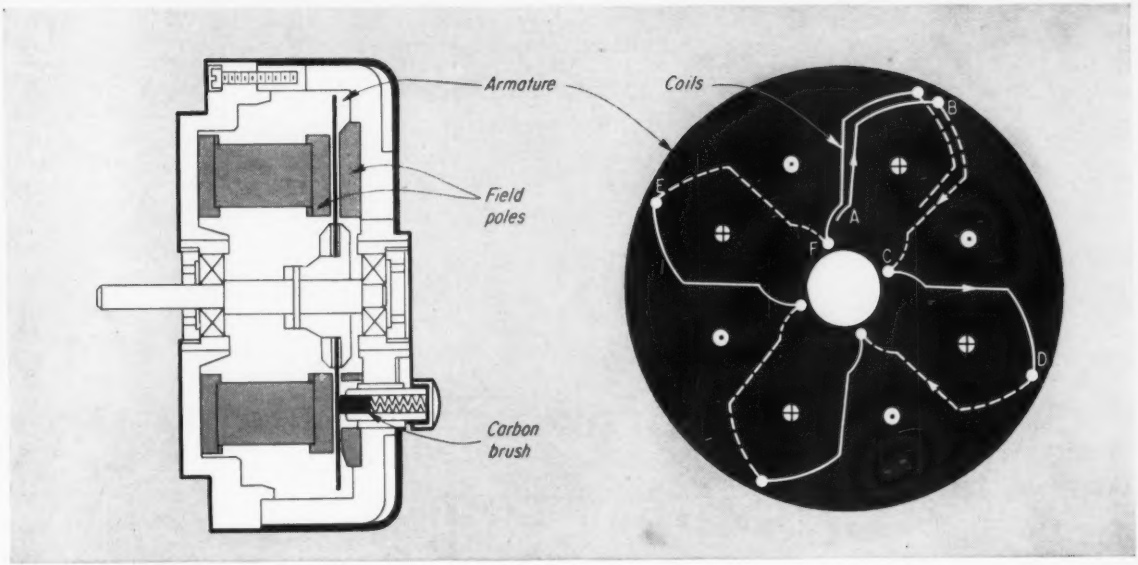
Armature winding for our machine is an 8-pole wave winding—circuit proceeds around all eight poles before returning to an adjacent commutator "bar." Active parts of conductors lie along radii; interconnections are made through the "end turns." "Bottom" coil sides are printed on reverse face of the disk (shown as dotted lines). Riveted and soldered connections are made between faces at inner and outer peripheries of disk.

Characteristics of printed-circuit motors differ from those of conventional types because of different construction. Some are advantageous, others not.

Armature's low inertia compared to its iron-core counterpart permits quick mechanical response to electrical input. Mechanical time constant may be designed to lie in 20 to 50 millisec range; then speed corresponding to a given terminal voltage can be reached about 80 to 200 millisec after applying voltage. Special-purpose machines may be designed to respond mechanically to inputs within a few thousandths of a sec.

Low inductance of the armature has a typical value of about 200 microhenries. Torque appears on the shaft at effectively the same instant terminal voltage is applied to the machine, providing fast mechanical response.

Torque is smooth and commutation nearly sparkless. Because of the large effective number of bars and be-



ARMATURE ROTATES in narrow circular air gap between permanent-magnet-field pole pieces. Brushes ride on armature segments in air gap. Armature "winding" follows wave pattern: *A* to *B* on front, *B* to *C* on reverse, around through closed loop

will they go?

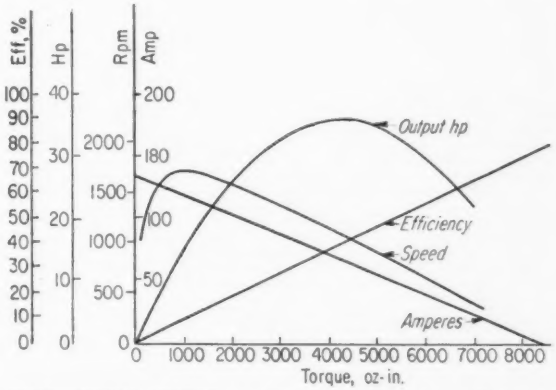
cause no iron rotates in the field, the output torque is smooth and free from cogging. This happy circumstance, coupled with general desirability of running motors at low speed, means they're well suited for direct drive.

High thermal capacity is inherent in printed-circuit design because (1) armature conductors are to a great extent exposed, and (2) radiation to the pole structure and (3) convection resulting from centrifugal-blower action of air in gap cool disk efficiently.

Speed limitations result from printed armature's susceptibility to eddy-current losses in the copper when rotated at high speed. Losses appear as a parasitic drag torque which increases with speed, flux density and copper thickness, is inversely proportional to square of number of armature conductors. These losses don't matter in small motors where efficiency is usually subordinated to low cost or some premium performance characteristic. In large machines existence of armature losses means generally that there should be as many armature conductors as possible when motor will operate above 1000 rpm, as may be needed for some applications.

Low operating voltage, compared with conventional machines, is necessary because printed armature is fundamentally a single-turn winding. For armature diameters ranging from 3.5 to 8.5 in., motor terminal voltage at 3000 rpm will lie between 6 and about 150. These levels are well suited to power-control devices using semiconductor elements.

Low overall cost compared with conventional motors begins once the drawing, tooling and processing of the armature are established. Price of the finished part includes virtually no direct labor cost. It consists



PERFORMANCE CURVES are for motor rated 1.5-hp continuous at 1500 rpm, 75-v dc input. Note linear speed-torque characteristic

almost entirely of cost of materials. Manufacturer expects the armature for a 10-hp machine eventually to drop to the $20-to-$30 range—right now we're a long way from this point, however. When the rest of the motor structure goes into mass production, manufacturing operations will involve little labor. Conceivably complete cost might be between $100 and $150.

Power capabilities, limited in present designs, can be expected to grow with applications. Continuous torque output permissible from printed-circuit construction rises at a rate proportional to the armature diameter raised to a power ranging from 3.5 to 4.5, depending on cooling method the manufacturer has selected for his design.

Much work remains to be done in the area of large torque producers, but some motor characteristics are highly compatible with philosophy of direct power drives. Motor's behavior in connection with semiconductor thyratrons as a controlled power source is being studied.

Ten years ago this month *Power* published a thought-provoking article, "If bombs wreck our power plants, will we have portable units to take over?" (Feb 1951, pp 82-83).

Specific subjects covered: military targets, after the attack and preparing for the day of attack, concluding with "Wanted—a program." Today, with nuclear attacks perhaps a greater possibility than ten years ago . . .

By JOHN PHILIPP
Mechanical Engineer
Burns and Roe, Inc

What about power plants—if attack comes?

Maintaining electric power during war emergencies is an important national-defense issue and a matter of great concern to all in the electric-utility industry. In this age of nuclear weapons we should consider effects of nuclear bombing on electric-power systems.

General consequences of nuclear blasts are personnel injured and killed, facilities damaged and destroyed. Countermeasures depend on whether personnel or facility protection is paramount.

Electric-utility personnel include many highly skilled people who are not easily replaced, especially in wartime. Their loss can cripple the utility's ability to keep its system operating—even if facilities are undamaged. Thus, providing adequate shelters at every power facility and central office is a basic requisite.

Shelter costs vary with degree of protection and comfort. But it's important to note that even the simplest underground construction greatly improves survival chances. A 3-ft earth fill would sufficiently protect people against fallout radiation. Too, fallout shelters give considerable blast protection because of the substantial thickness of material needed for radiation shielding. Design can take advantage of the plant's heavy foundations to increase the shelter's blast resistance without increasing cost. Direct entrance from basement-floor areas cuts warning time.

Equipment in the shelter should include everything necessary to protect and house personnel: a ventilation system (including chemical-biological-radiological filters), water and food storage, protective clothing, sanitary facilities and sleeping quarters. Instruments for monitoring contamination levels within and outside the plant also are mandatory.

Continuous plant operation during radiological contamination periods is a fringe benefit of the personnel-oriented fallout shelter. Under certain conditions radioactive fallout may contaminate distant areas where blast, thermal and initial radiation have no significant effects. A power plant situated in the fallout path might not suffer any material damage, yet its personnel would be forced to take shelter for the entire heavy contamination period—an acute hazard lasting for hours, days or weeks depending on fallout intensity.

In most cases radiation dose rate will decrease enough in a few days after explosion to allow limited activity outside the shelter. The buttonup period will generally coincide with the recovery phase of civil-defense efforts following atomic attack. A utility in a contaminated area, but not otherwise directly affected by the explosion, may have to supply power to neighboring distress areas where generating facilities have been demolished.

Modern stations with their centralized controls and already high degree of automation are generally well suited for automatic or remote-control operation. Essential monitoring and operating functions would be transferred to the shelter area. Monitoring, for example, would scan control-room panels with closed-circuit-TV cameras. Important load and trip controls could be duplicated on an auxiliary panel in the shelter. An alternate solution to be considered: completely shielding the control room against radiation with sandbags or concrete panels.

Need for periodically attending all manually operated equipment may impose time limits on such automatic operation. This is particularly true with coal-fired steam plants. But with adequate warning time and proper planning, manual functions could be deferred until after the critical contamination phase if fallout is not excessive. Example: coal bunkers, usually designed to store a 48-hr week-end coal supply, can be kept full during an alert period. Final preparation for the buttonup takes advantage of time lapse between explosion and fallout arrival. All this activity must be organized so no individual receives an accumulated radiation dosage exceeding a safe limit. Plant operating personnel should get special training in atomic-defense principles. The training should include principles of radiological decontamination and monitoring.

Power-facilities protection against nuclear attack must be viewed within realities of peacetime economy and anticipated wartime emergency requirements. Maintaining essential electric power in areas not completely destroyed is considered of prime importance and protec-

"Preparedness" is more than a word among utilities today

This article is intended to be both informative and provocative. But it's by no means an attempt to advance a "scare" philosophy. Admittedly an unpleasant subject, attempted nuclear attacks must be regarded as possible. "Possibility" is the basis upon which specific defense measures are planned by departments of the Federal Government.

In this vein the U.S. Dept of the Interior, in cooperation with electric utilities across the country, has established a Defense Electric Power program. Its purpose: insure, so far as possible, minimum interruption in flow of power to facilities necessary to a sustained and effective defense effort.

Key men in electric-utility systems today stand ready to pick up the reins. If a situation develops these men are immediately relieved of routine administrative duties and take over direction of emergency operations. An alternate for each man, spotted geographically at a safe distance, is immediately available in case his principal is incapacitated. For complete information on the setup, you can order a copy of the *Electric Power Emergency Operations Handbook* from the U.S. Govt Printing Office.

In this article we talk about plotting varying degrees of destruction or damage by simulating bomb drops and establishing potential ground zero at various points in the system. This procedure was carried out by the author with cooperation of several large systems. He made several assumptions: (1) Everything within a radius of 8-mi from ground zero would be destroyed. At this distance a 20-megaton explosion would generate an overpressure of almost 8 psi and a drag pressure corresponding to a 250-mph wind velocity. He also assumed that no blast damage would occur beyond the 8-mi radius. (2) There would be no shortage of electric power so long as adequate transmission and distribution facilities were available. (3) Destruction of some facilities would have no effect on electrical stability of the system. (4) Suitable means were established for correctly paralleling transmission lines if critical lines were lost.

Evaluation of effects on one system revealed that no large areas outside the range of complete destruction would be isolated from power supply as the result of a single blast. Transmission would be adequate to import power to sections not destroyed, though perhaps badly in need of help.

Positive features of the system: major substations were separated from the generating station and dispersed; main transmission facilities formed a loop feeding distribution substations; links with other systems were deconcentrated. These advantages outweighed the negative feature of a single generating facility for the whole system.

Analysis of another system showed that its major asset was its loop arrangement of transmission facilities and multiplicity of switching stations throughout the area. However, three out of four major connections with outside areas converged at a single sub and consequently were vulnerable.

In a third, multi-generating-station, system, analysis showed that complete demolition of the system's center—where the major generating stations are concentrated—would not necessarily cause a power blackout in surrounding areas. Large portions of these undamaged fringe areas would be supplied with imported power through switchyards outside the perimeters of destruction.

These analyses point up that, despite the highly unpredictable factors of bomb capacity and ground zero, actual system plotting of possible damage areas can be done. Avenues of possible countermeasures have been outlined to some degree.

A spot check of some utilities by POWER indicates that personnel training — atomic-defense principles, radiological decontamination and monitoring—ranges from considering initiation of such programs to serious, in-being procedures. So far as blast and fallout shelters are concerned, POWER didn't learn of any construction specifically for this purpose. Some utility people indicated that subgrade construction features presently incorporated in central-station design were deemed substantial enough for shelter purposes—providing, of course, station location was not at or near ground zero.

A number of systems presently employ self-contained generating units for peaking service, though none are mobile in the strict sense. However, it is agreed that, with a minimum of effort, some units could be quickly moved for service at other points.

In general, there is little doubt that electric utilities are well aware of the role they must play in the event of a nuclear attack. They have plans for definite action. To what degree the author's proposals are considered is, of course, a matter of decision by utility management.

tive measures must be geared to this objective. Most-appropriate measures can be determined by evaluating effects on individual power systems.

Complete analysis would require first a prediction of size and number of attacks. Next, degree of damage to both utility and its customers would have to be evaluated on basis of location and resistance of individual structures and equipment—obviously a tough assignment.

In lieu of this complex procedure practically any system's vulnerable points can be detected by a relatively simple method. Assume, for example, that a 20-megaton explosion would completely destroy everything within a radius of eight miles from ground zero. Larger-capacity bombs would, of course, destroy larger areas.

By taking any system map and scribing circles to scale with a pair of dividers, using one leg to denote potential ground zero, you can plot areas of varying degrees of destruction or damage. From here on in it

is simply a matter of planning, so far as possible, how to keep the power flowing or reestablish supply to critical areas to permit defense operations to function.

Switchyard dispersal, system tie-ins

Previous planning is about the only practical way to reduce long-time outages caused by switchyard damage. Many utility outside-plant layouts locate major switchyards so that if one were demolished, power in its area would not be available for many days. Where such a pattern exists you should plan to distribute these critical switchyards so destruction of one will not cause a power blackout in a relatively large area. Smaller switching points, built to eliminate critical focal centers, should have adequate transmission ties between them so a complete loss of two or three will not block power flow to damaged areas. Circuit simplicity—both power and control—is paramount in restoring operation under stress of emergency.

Separating switchyard from generating station is fully as important as switchyard dispersal. As a principal target a generating station is vulnerable; major repairs take months. Since substantially all the net power is exported over high lines, main generator-stepup transformers are located at the generating site and considered part of the facilities whose function is to furnish power at transmission voltages. The high-voltage switchyard and transmission circuits accompanying a generating station should, therefore, be separated from it. If your station is put out of service completely, transmission lines and switchgear still have an important function to perform —bringing power into the damaged area. Stations should furnish power over high lines to two or more switchyards remote from the generating site to better insure usability of transmission lines when station itself is demolished.

Additional ties between systems should be made at several switching points, preferably at some distance from each other, to cut possibility of severing all transmission lines between two systems. In planning outside-plant facilities in some systems, it's possible to provide switchyard connections for power-barge tie-in to the system without having to construct additional power lines and substations.

Portable units spotted throughout system

Adequate transmission facilities and extensive interconnections cannot be overemphasized. But of course other means may be needed to meet emergency requirements. Since the localities at which emergencies might occur are essentially unpredictable, it appears that highly mobile self-contained power units could best solve the problem, particularly when relatively small loads are involved.

Standby generating sets must be available for quick dispatch to any point in the system. Upon arrival a unit would need only electrical connections and a fuel supply. Within hours, power could be fed to the network. These portable plants should be stationed at widely scattered points to insure their availability and prevent their mass destruction by enemy action. Best locations: near load centers the units are most likely to serve. In an emergency at outlying points the portable sets would move from their assigned spots to the stricken area, connect to working portions of the electric-distribution system.

Each permanent setup would consist of one or more self-contained mobile generating sets, fuel-storage and transfer system, electrical connections to the distribution system and a general storage area. Reinforced-concrete structures hardened to resist a distant atomic blast should house these standby stations. Structures could also store spare transmission and distribution equipment, steel towers, wood poles and other replacement parts necessary for quick restoration of electric system.

Studies should be conducted on the probable need for portable-unit reserve capacity. They should be based on territorial requirements of several neighboring utilities rather than individual system needs. An adequate mobile reserve should amount to only a small fraction of system installed capacity.

Peaking service is a potential duty for emergency plants in a peacetime economy. One problem facing electric companies is that capacity must be available in generating, transmission and distribution facilities to meet maximum short-term demands imposed by their customers. Population growth and rising electricity consumption per capita demand ever-increasing investment for power facilities. Large investments required by new high-efficiency steam units can't be justified unless substantial savings in fuel consumption can be anticipated.

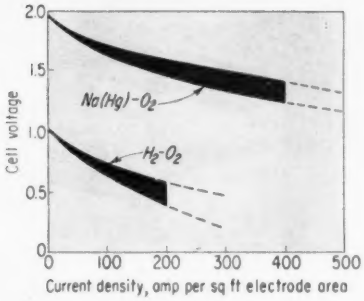
Frequently, today, special units are economically preferable for short-time peak loads. Emergency power sets are well suited to this service. They can be used to defer high-cost generating units or to avoid demand charges for large blocks of power in advance of actual need. Portable plants dispersed throughout the system and spotted at the load end of transmission lines can reduce line losses during peaks. Fuel savings associated with the low-spinning-reserve quick-starting units sometimes add up to real money.

Diesel engine and gas-turbine drive seem particularly suitable for mobile units. Steam plants could more easily be used on barges or ships where cooling water is no major problem. Land units must mount on highway trailers or railroad trucks: highway units offer greater mobility; railroad cars can carry heavier loads.

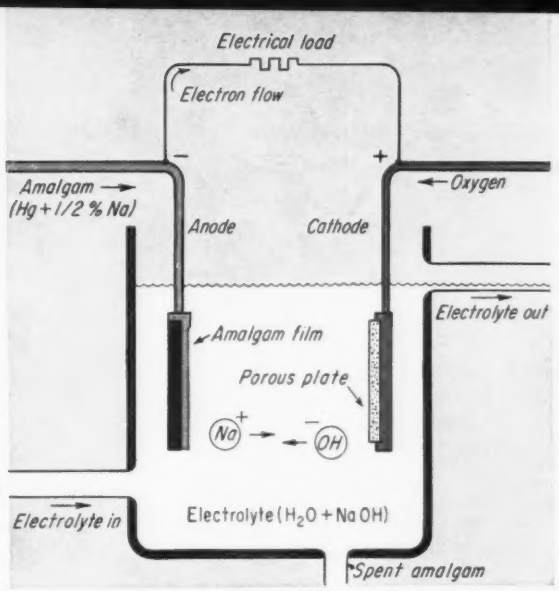
A self-contained emergency set would include a heavy-duty engine designed for prolonged continuous operation, oil- and water-cooling radiators, necessary startup gear, fuel-oil system with day tanks, lube-oil and compressed-air systems, generator with exciter, switchgear auxiliary generator and other appurtenances. Provide a cable reel and several portable cables with suitable clamp terminals. And units you're considering for peaking service should be equipped for remotely initiated automatic operation.

Floating power plants offer a unique combination of features. Constructed on ships, such plants can attain capacities comparable to stationary units, yet their mobility in navigable waters is virtually unrestricted. A relatively low-cost floating power plant in the modified hull of a surplus cargo vessel can be attractive to coastal or river utilities.

Electric-system vulnerability to nuclear-bombing effects can be cut to a minimum through long-range planning. Protective measures should be carefully coordinated with your utility's normal expansion.



HIGHER VOLTAGE is one big advantage of sodium-amalgam cell. Units are tied in series to develop necessary final potential



ACTUAL DESIGN varies from that shown. Real cells use a cylindrical anode within a cylindrical cathode, electrolyte between

75-kw fuel-cell package uses sodium amalgam

A new hat is in the fuel-cell ring. This news broke as M W Kellogg announced another fuel-cell type plus a Navy contract to develop a 75-kw chemical power plant. Latest cell combination (for details on others, see POWER, Nov 1960, pp 59-63) operates on a mercury amalgam of sodium, oxygen and water. It develops twice the voltage of hydrogen cells, see curves above. In contrast to the hydrogen-oxygen cell, this mercury-amalgam device promises a sharp cut in overall plant size.

The prototype will weigh between two and three lb per kwhr of capacity. It should be 15 times lighter than storage batteries now in use. From an efficiency angle, Kellogg figures 60%, producing electricity at $.27 per kwhr.

Like all fuel cells, the sodium-amalgam-oxygen cell is a continuous-feed primary electric battery in which energy from an electrochemical reaction converts directly into low-voltage-dc electrical energy. In the now-familiar hydrogen-oxygen cell, basic reaction is the combination of hydrogen and oxygen to form usable electricity and water. Basic reaction of the sodium-amalgam cell is:

$$4Na + O_2 + 2H_2O \rightarrow 4HaOH + \text{energy}$$

This reaction has long attracted attention from researchers because of the high cell voltage made possible by the high position of sodium in the electromotive series. But direct application is complicated by the pronounced reactivity of sodium. Any attempt to use pure sodium in an aqueous electrolyte would clearly lead to an explosive reaction. But in the amalgam the direct reaction of sodium with water is suppressed while the sodium is made available for electrochemical use.

In operation the dilute sodium amalgam (a liquid with physical properties similar to mercury) is supplied to the cell, producing a thin flowing film on surface of a steel plate, above, right. This film forms the cell anode. A portion of the sodium is stripped from the film; depleted amalgam falls to cell bottom and is removed.

Oxygen gas is supplied to the hollow cathode, one surface of which is a specially formed porous plate of sintered metal or carbon. Space between the electrodes is filled with electrolyte, an aqueous solution of sodium hydroxide. At the amalgam anode the reaction is:

$$(Hg)\ 4Na \rightarrow 4Na^+ + 4 \text{ electrons}$$

$$\text{Sodium amalgam} \rightarrow \text{sodium ions in electrolyte} + \text{electric current}$$

Anode electrons then travel through the external circuit to the cathode where they react:

$$4e + O_2 + 2H_2O \rightarrow 4OH^-$$

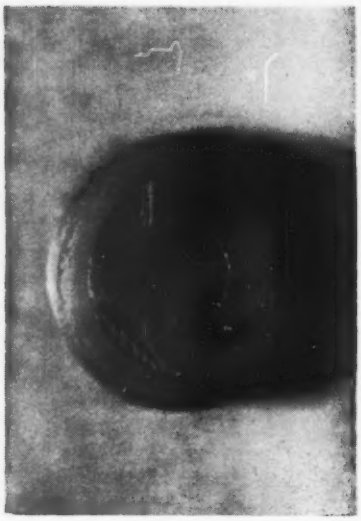
In electrolyte the sodium and hydroxyl ions form an ionic solution of sodium hydroxide:

$$4Na^+ + 4OH^- \rightarrow 4NaOH$$

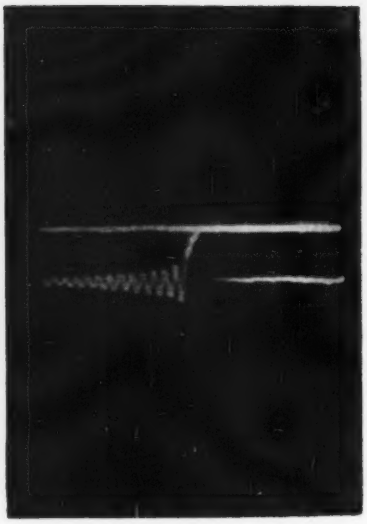
Systems design enters the picture, as you would expect. Designing a satisfactory cell is only a part of the problem in developing a fuel-cell power plant. A complete plant must include not only a system of chemical supply, but means of controlling amalgam and electrolyte concentration, together with sensing, circulation and heat-transfer apparatus; last removes heat generated in the cells. Result: a chemical-process plant in miniature, with cells connected in series to produce the necessary higher voltage.

Other developments in the fuel-cell area keep coming along. An experimental model of a lightweight regenerative fuel cell was recently announced by Electro-Optical Systems, Inc of Pasadena, Calif. The hydrogen-oxygen cell shown by EOS should provide 15 to 75 whr per lb.

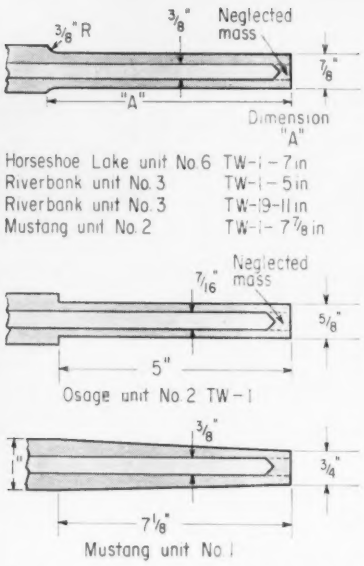
A final interesting note: world's first vehicle powered by self-contained and controlled fuel cells (POWER, Dec 1959, p 168) was recently presented to the Smithsonian Institution in Washington, D.C. by its developer, the Allis-Chalmers Mfg Co of Milwaukee, Wis.



1 Thermometer wells fractured because of fatigue stresses below their threads



2 Oscilloscope trace spanning five milliseconds fixes the well damping ratio



3 Dimensions of wells that failed in three steam lines during operation

Thermometer-well failures traced to

Several well failures led to a study of their causes. This analytical study showed that steam vortices shedding downstream from the well set up severe vibration in the well

Studies of thermometer-well failures at stations of the Oklahoma Gas and Electric company led us to conclude that they were caused by vibration induced by steam flow. These vibrations could set up stresses of 75,100 psi, compared to an allowable 5500 psi, in a well in the Horseshoe Lake Unit 6.

Fatigue failure, Fig. 1, shows that the metal must have vibrated extensively before breaking. Fig. 3 shows dimensions and shapes of the wells that failed. Point of failure: at the pipe wall supporting the well.

For the Horseshoe well the aerodynamic drag of the steam, at full load on the unit, induced a stress of only 1700 psi at the point of failure. This is well below the allowable 5500 psi at working temperature. A well-rounded fillet at this point minimizes stress concentration.

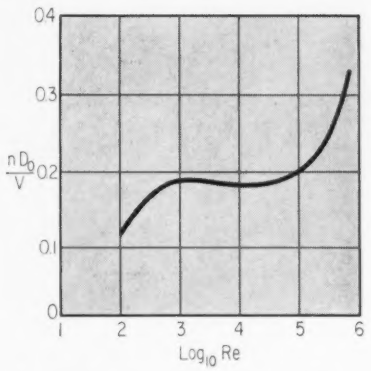
Smokestacks, pipelines, bridges and other structures have failed because of wind-induced vibrations. These have been caused by periodic shedding of eddies or vortices from alternate sides of the cylindrical body. These vortices were mathematically predicted by Theodore Von Karman. Several articles listed in the bibliography discuss these effects, particularly related to smoke stacks.

Vibration of the well depends on the frequency with which the vortices in the steam are shed from the trailing surface. To cause the vibration, the shedding frequency must about equal natural or resonant frequency of the well. In addition, the applied periodic force must overcome the internal damping of the well. When vibration-induced stress exceeds endurance limit of the material, the well will fail.

Calculations of natural frequency of the wells have been based on a simplified shape, Fig. 3, that assumes a uniform hollow cylinder. This neglects the mass of material at the end of the bore, gives an answer slightly higher than true frequency.

We compared these figures with an actual measure of natural frequency of a well similar to the one that failed at Horseshoe Lake. This measure also gave data for figuring internal damping of the well from an oscilloscope record. The transducers were strain gages mounted on the well and the oscilloscope registered output of a bridge circuit including the gages.

Conclusion: every thermometer well, particularly one in a high-pressure steam line, should be designed so resonant frequency of the well is at least 1½ times maximum exciting frequency of the Von Karman vortices. If this can't be done, check that the exciting force is low enough and internal damping high enough to avoid inducing a stress greater than the allowable working stress.



4 Graph relates Reynold's number to Von Karman vortex frequency of steam

vibration

By TOM J LOVE, Assistant Professor
The University of Oklahoma

How to calculate thermometer-well stress

Hydrodynamic drag:

$$F = C_d \frac{\rho v^2}{2g} = A$$

from *Engineering Hydraulics*, p 126.

Stress induced by drag:

$$S = \frac{Mc}{I}$$

Moment, assuming uniform distribution of drag force over length:

$M = F \times length$

$I = \pi (D_o^4 - D_i^4)/64$

Well natural frequency:

$$f = \frac{0.56}{L^2}\sqrt{\frac{EIg}{ad}}$$

$a = (D_o^2 - D_i^2)\pi/4$

Von Karman vortex frequency:

$\phi (Re) = nD_o/v$ (Strouhal's number)

$\phi (Re)$ is found from Fig. 4 after finding:

$$Re = \frac{D_o v \rho}{\mu}$$

$n = \phi (Re) v/D_o$

Von Karman vortex force:

$$F = 1.7\left(\frac{v^2\rho}{2gc}\right)A$$

Vibrational amplification (approximated by one deg of freedom system):

$$\text{Amplification} = \frac{1}{\sqrt{\left(1-\frac{\omega^2}{\omega_n{}^2}\right)^2 + \left(2\,\frac{C}{C_c}\times\frac{\omega}{\omega_n}\right)^2}}$$

When $\omega = \omega_n$, that is, the exciting frequency equals the natural frequency, we have maximum amplification with C/C_c greater than 1.0. Then:

Amplification $= \frac{1}{2}\,(C_c/C)$

C_c/C was determined experimentally by mounting the well horizontally in a heavy steel fixture. Two SR-4 strain gages were fixed to the top and bottom surfaces near the base of the threads on the well. Gages were connected into a bridge circuit with an oscilloscope.

A 54-lb weight suspended from the outer end of the well was suddenly knocked off by a horizontal blow to set the well vibrating. Fig. 2 shows the oscilloscope trace from which X_o, X_n and N can be found for:

$$2\pi\frac{C}{C_c} \approx \frac{1}{N}\ln\frac{X_o}{X_n}$$

Formula notation

- A = Projected area perpendicular to steam flow, sq ft
- a = cross section of well perpendicular to axis of cylinder, sq in.
- c = distance from neutral surface to extreme fiber, in.
- C = damping of system
- C_c = critical damping of system
- C_d = coefficient of drag
- d = density of metal, lb per cu in.
- D_i = inside diameter of thermometer well, in.
- D_o = outside diameter of thermometer well, in.
- E = Young's modulus, psi
- f = natural frequency, cps
- F = force exerted on body, lb_f
- g = dimensional-conversion constant = 32.3 lb_m-ft per lb_f, sec
- I = area moment of cross section about neutral axis, $inch^4$
- L = free length of thermowell, in.
- M = moment, in.-lb_m
- n = frequency of Von Karman vortices, cycles per sec
- N = number of cycles
- Re = Reynold's number
- S = stress, lb_f per sq in.
- v = steam velocity, ft per sec
- V = absolute viscosity, lb_m per ft, hr
- X_o = initial amplitude of vibration
- X_n = amplitude after N vibrations
- ρ = mass density of steam, lb_m per cu ft
- μ = absolute viscosity, lb_m per ft, hr
- ω = frequency of vibration
- ω_n = natural frequency

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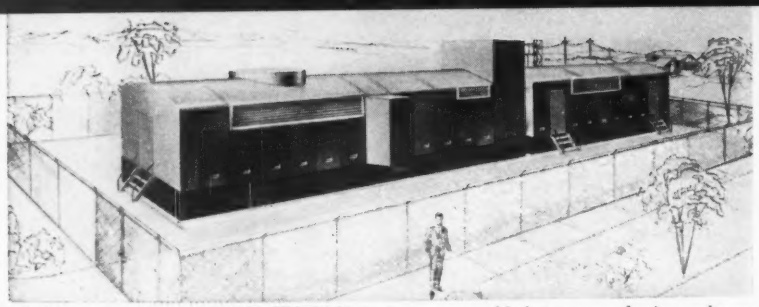
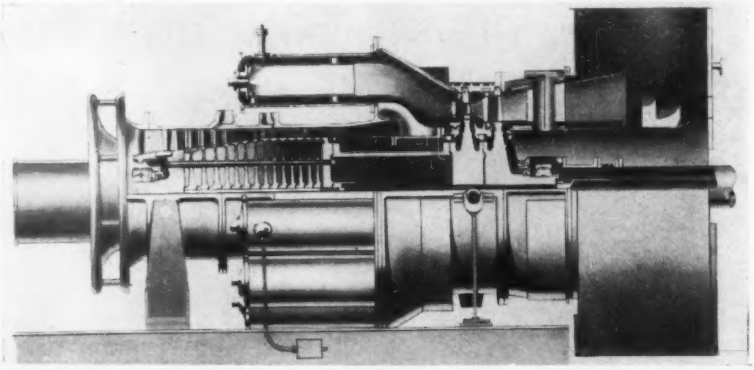
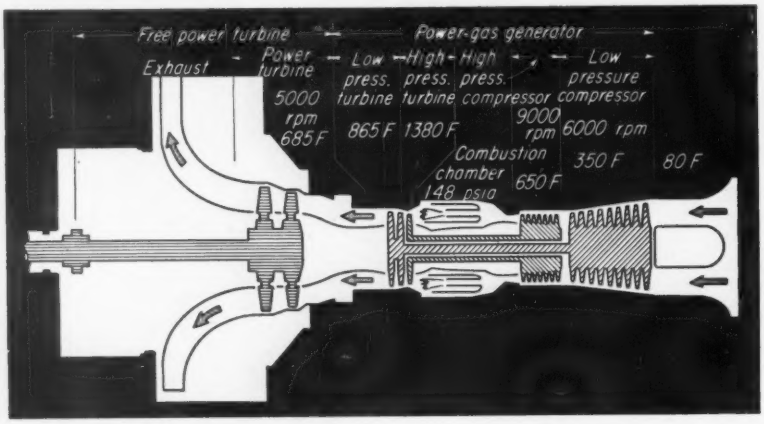


NEW 11-mw GAS-TURBINE STATION is factory-assembled into two basic packages (1) power unit, left, housing turbine and controls (2) generator unit, right, with exciter

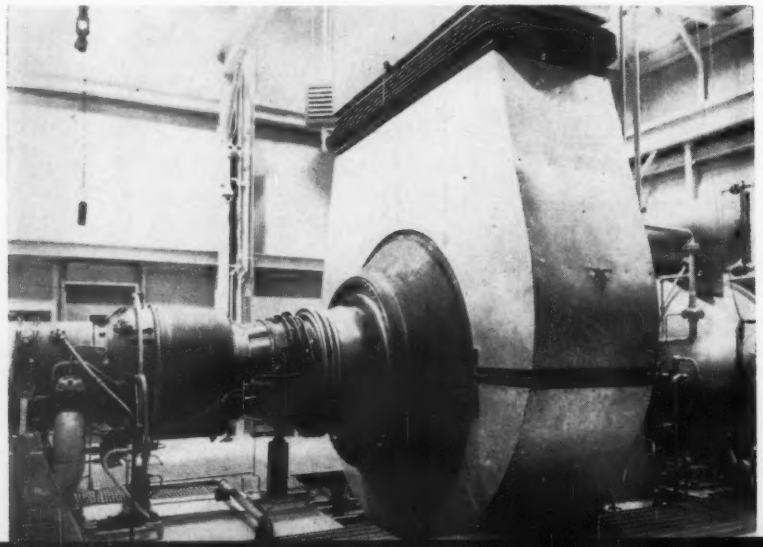


SIMPLE-CYCLE SINGLE-SHAFT GAS TURBINE generating 11 mw fills demand for intermediate capacity for peaking service. Turbine is development of locomotive unit



GAS TURBINE FOR PIPELINE-COMPRESSOR drive develops 10,500 bhp and features 2-shaft power-gas generator (a jet engine), right, feeding gas to free-power turbine, left

ADAPTED J-57 JET ENGINE, left, generates power gas for gas turbine in exhaust hood in Clementsville, Ky. compressor station of Columbia Gulf Transmission Company



How new

South Carolina Electric and Gas Company has ordered four gas-turbine packaged power plants from the General Electric Company. Each plant will generate a gross of 11 mw for a 10.75-mw net output. Two of the units will serve in the Beaufort, S. C. area starting June 1961 and the second two in the Charleston, S. C. area in mid-'63. The packaged plants cost $100 per kw for the basic units delivered at site.

Ground dimensions, top picture, are about 80 x 35 ft. The power package (10 x 36 ft) houses the gas turbine, unit controls, auxiliaries, batteries and charger, closed-loop cooling system and starting equipment for the gas turbine.

The generating package (10 x 28 ft) houses the air-cooled generator, reduction gear, exciter, current transformers, field breaker, discharge resistor and generator-air filter systems. Accessory equipment includes inlet and exhaust ducting and the outdoor metalclad switchgear compartment. With nominal advance land preparation, plant can be erected and started within ten days of delivery at the site.

Operations. All starting, synchronization, operation and shutdown functions can be controlled remotely. From cold shutdown the plant can go on the line and carry full load in 15 minutes.

The integral control room can be in a separate cubicle for a multi-unit plant. Compartment next to the turbine holds the starting diesel and most of the turbine auxiliaries. Key

gas turbines meet challenges

components include the closed-loop cooling system with a roof fan and radiator surfaces in the side of the house, see top picture at left.

Air-inlet ducts for the compressor project from the side of the house. These may be fitted with filters and coolers as needed.

The gas turbine runs on either gas or distillate oil. The all-weather housing gives both thermal and acoustic insulation. Hinged side panels, when raised, form a protective roof during maintenance work and plates covering the I-beam base swing out to become a walkway.

Accessories. When package must go to work near residential areas, silencing equipment can be mounted atop the turbine-exhaust stack. The generator package houses the reduction gear, generator, exciter and generator - cooling air - filtering system. Conventional outdoor metalclad switchgear for plant output stands next to the generator package. Plant has a crane to handle the heaviest parts during maintenance work.

The packaged plants can be moved to other locations as needed on a utility system. This flexibility plus relatively low investment cost offers advantages to a regional system, helping minimize overall system investment as loads expand at different rates on various parts of the system.

The $100-per-kw cost of these units compares with about $130 per kw for conventional steam plants in the South Carolina area. Coal and gas fuels cost about 30 to 33¢ per million Btu delivered at the generating plant.

Experimental compressor drive

Columbia Gulf Transmission Company has placed an experimental gas turbine driving a gas compressor in operation in its Clementsville, Ky. plant. The unit adapts a Pratt & Whitney Aircraft J-57 jet engine to serve as a power-gas generator for a 10,500-hp 2-stage power turbine built by Cooper Bessemer Corporation. Idea was brainchild of Cooper-Bessemer; they market unit, pictures, left.

Unit was first tested at the Wilgoos Lab of Pratt & Whitney at East Hartford, Conn. The tests were highly successful and showed the unit could run at 25% thermal efficiency without regeneration because of the high pressure ratio (10) of the jet-engine gas generator.

A complete gas-pumping station with the new unit is estimated to cost $190 per installed hp; a comparable reciprocating plant would run about $365 per hp; a conventional industrial gas-turbine plant would be somewhat less. Part of the economy comes from the mass production of jet engines by Pratt & Whitney—they have over 19,000 engines in service.

The new gas turbine weighs 3.2 lb per hp compared to 65 lb per hp for a conventional reciprocating engine. The conventional gas turbine weighs about 16.5 lb per hp.

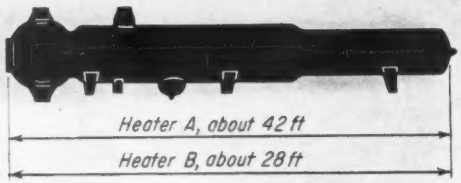
Foundation weight and space needs for the three types: new unit, 52 lb and 0.12 sq ft per hp; reciprocating engine, 402 lb and 0.4 sq ft per hp; conventional gas turbine, 177 lb and 0.18 sq ft per hp of rated capacity.

Advantages of the new gas turbine: little cooling water needed, low lubricating-oil consumption, elimination of vibration, uniform torque, no stepup gears needed. Major advantage of the experimental unit: a gas generator (jet engine) can be removed and replaced with another one in four hours' time. The removed unit can be returned to factory for overhaul. This should yield large savings in maintenance and downtime.

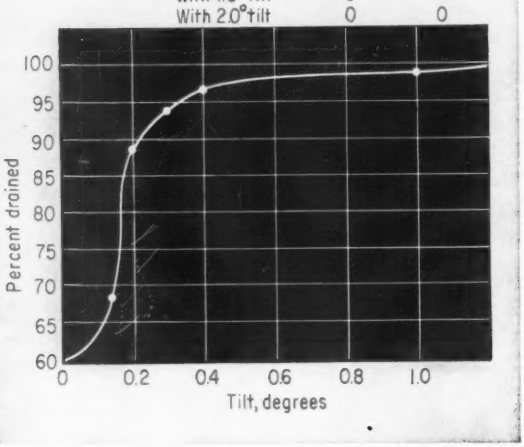
Aircraft jet engines boast a good performance record; gas - generator performance is expected to be better. In an aircraft the engine works at widely varying loads and overloads subject to severe thermal stresses. As a compressor drive the engine will mostly operate under constant load, won't suffer severe thermal shocks caused by sudden load changes.

The new unit will run for 3000 hr or elapsed time of 18 months, whichever comes first. Then the test results will be evaluated. The jet-engine section of the unit is estimated to require overhaul about every 8000 operating hours. The test may show that this time can be lengthened.

The jet engine is a 2-shaft unit with a normally rated thrust of 12,000 lb. The single-stage h-p turbine drives the 7-stage h-p compressor and the 2-stage l-p turbine drives the 9-stage l-p compressor. H-p turbine inlet temperature will be 1380 F at full load. The 2-stage power turbine will have a full-load inlet temperature of 685 F and turn at 5000 rpm. The gas-generator h-p turbine runs at 9000 rpm and the l-p turbine at 6000 rpm.



	Gallons of water	
	Heater A	Heater B
Tube capacity	740	440
Water drained -Level position	433	260
Water remaining-Level position	307	180
With 0.2° tilt	83	55
With 0.4° tilt	17	–
With 1.0° tilt	6	–
With 2.0° tilt	0	0



TILT OF HORIZONTAL HEATERS controls amount of water that can be drained from tubes with the heater out of service. Residual water left in tubes in outdoor heaters can freeze up in winter weather and rupture them; be sure to drain thoroughly

Here's a timely warning . . .

Feedwater heaters can freeze up

By WAYNE E GLAUSSER, Head
Apparatus Engineering Dept, C F Braun & Co

If you have feedwater heaters outdoors and shut them down during cold weather, water remaining in the tubes may freeze and burst them. One such failure has been reported, so we wondered—how well do feedwater heaters drain when they are taken out of service?

Tests made with both full-scale heaters and single tubes, carefully leveled, showed a surprising 40% of tube capacity remaining after the tubes have been allowed to drain. Problem: how to remove residual water? Tilted installation raises problems of fabrication and level control. Probably the best answer is to evaporate the water by steam heating from the shell side.

Full-scale tests were made with two new heaters, one with 25-ft and one with 35-ft tubes. Heaters were leveled and filled with water. Then all vents and drains were opened. When the water stopped draining, the back end of the heater was raised and the water that ran out was measured.

The heater was tilted in several steps to find the angle needed to remove essentially all the water. Table, left, shows it takes a tilt of about one deg to be sure the tubes are completely drained. The shell side gives no problem —it drains almost completely in the level position.

Single-tube tests were made with $\frac{5}{8}$-in.-OD 18-ga tubes on a 20-ft straight tube and a U-tube with 20-ft legs. Tubes were cleaned with detergent and steam to rule out any oil effect. Tests were run on a planer bed to assure levelness. The U-tube was supported with the bend in the vertical plane by drilled wood blocks, accurately leveled. Result was the same as with the heaters: about 40% of capacity does *not* drain from a level tube.

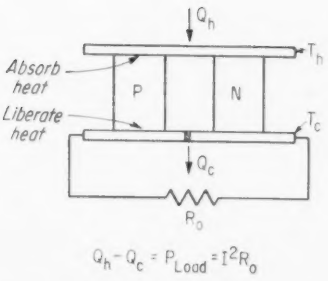
A one-deg tilt sounds small. But with long feedwater heaters it means raising the back end considerably—$7\frac{1}{2}$ in. for a 35-ft heater or $5\frac{1}{4}$ in. for a 25-footer. Building a heater for this much tilt raises several problems. If the heater has a full-length subcooler, some tube rows must be left out to avoid flooding part of the condensing surface. This calls for a larger diameter and more-expensive heater. Too, nozzles extending up or down must be specially installed to compensate for the tilt so as to maintain the terminal face of the nozzle in the horizontal plane. This adds still more to the cost.

A tilt of 0.2 deg will get rid of all but about 10% of the water. This much tilt involves little problem with liquid-level control, and the nozzle tilt and misalignment can probably be accommodated in the piping. But without further testing there is no way of knowing whether the 10% water remaining in the tubes will cause trouble.

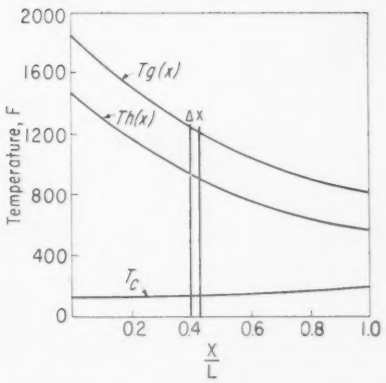
Blowing the water out with air was investigated. We figured an air speed of at least 50 ft per sec was needed. For an average-size heater this would need about 3500 scfm. Tests were made on one full-size heater. Only about 15% of the residual water could be blown out with 100-psig plant air through a $\frac{1}{2}$-in.-ID hose connected to the top of the channel. So air blowing is not a practical method for removing all the water in a heater.

All tubeside water can be removed by evaporating it with steam in the shell; heaters can stay in the level position. First open all vents and drains to remove as much water as possible. Then admit low-pressure steam to the shell. Residual water in the tubes evaporates and leaves through the tubeside vent and drain connections. When the vapor plume stops, shut off the steam and open all the shellside vents and drains in the heater.

Development of efficient thermoelectric materials leads to their experimental use for electric generation. Here are the factors that must be considered in laying out and . . .



1 Thermocouple receives high-temperature heat for conversion to electricity



2 Gas temperature drops as the gas flows through a thermoelectric generator

Designing a thermoelectric generator

By B W SWANSON, Research Laboratories, Westinghouse Electric Corp

A thermoelectric generator has a collection of electrically connected thermocouples receiving and rejecting heat energy. The energy source may be chemical, nuclear or solar. The energy sink may be the air or water. Energy flow from source to couples to sink may be by radiation, conduction or convection or any combination of the three. The generator must have a structure to hold the thermocouples and auxiliaries.

Generator designs may be made of all possible combinations of the factors mentioned. We will consider a particular design; for energy source we'll use a chemical fuel burned in a combustor. The heat sink will be a coolant flowing through a jacket. Energy flow will be by forced convection. The generator will have a blower, combustor and thermoelectric duct. Now let's consider fundamentals first.

Thermocouples. Fig. 1 shows a single thermocouple connected to an electric load. The couple has two materials, P and N, connected to a thin copper strap at the top and to two thin copper straps at the bottom. These are electrically insulated and connected to the load.

With the hot junction at temperature T_h and the cold junction at T_c for a difference of $T_h - T_c$ across the couple, a thermoelectric voltage is developed:

$$E = (a_P + a_N)\ (T_h - T_c) \qquad (1)$$

where a_P and a_N are Seebeck coefficients for P and N type materials.

The current in the load circuit is:

$$I = \frac{E}{R + R_l} \qquad (2)$$

where R is the couple's internal resistance and R_l is the external load resistance. Power delivered to load:

$$P = I^2R_l \qquad (3)$$

For a thermocouple, optimum efficiency P/Q (ratio of maximum load power to heat flow rate that must be supplied to the hot junction) is:

$$P/Q = E_c E_{tc} \qquad (4)$$

where E_c is the Carnot efficiency $(T_h - T_c)/T_h$ and E_{tc} is the thermocouple efficiency. Latter is a known function of the hot- and cold-junction temperatures and a parameter M known as the "figure of merit." M is an index of efficiency of the thermocouple materials:

$$M = \frac{T_h a^2}{[\sqrt{\rho_p K_p} + \sqrt{\rho_n K_n}]^2} \qquad (5)$$

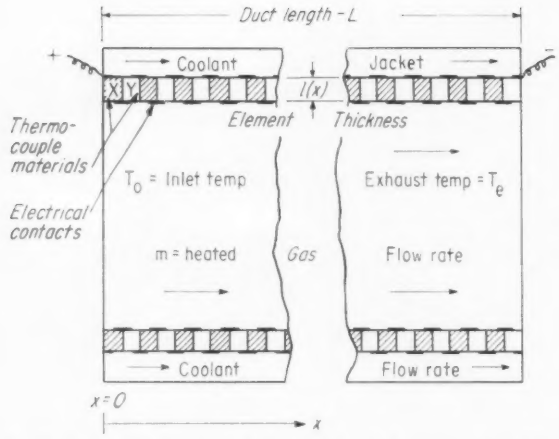
where ρ and K are electrical resistivity and thermal conductivity of the materials. Thermoelectric materials should have high figures of merit, in other words, high values of a and low values of ρ and K. The higher the figure of merit M the higher the thermocouple efficiency E_{tc} and the overall thermal efficiency P/Q.

Open-cycle generator is shown in Fig. 4. A blower drives ambient air into a combustor to burn a fuel. Hot gas from the combustor flows through a duct lined with thermocouples, Fig. 3.

As the hot gas flows through the duct, its average temperature drops since heat transfers by convection to the thermocouple surfaces, by conduction through the thermocouples and by convection from the thermocouples to the coolant stream. Since the hot-gas temperature falls off along the duct, hot-junction temperatures drop as shown in Fig. 2. Since temperature rise of the coolant is assumed to be small, cold junctions are practically at constant temperature.

This generator type can be considered to be a large number of stages of length ΔX, each consisting of a single thermocouple connected to its neighbors. A thermoelectric generator can be considered a number of stages in series. Each stage has a different E_c and E_{tc} and so different thermal efficiencies. The output of the generator is the sum of stage outputs.

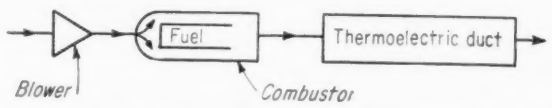
Suppose all thermocouple stages have the same length l. Then the cross-sectional areas of the P and N



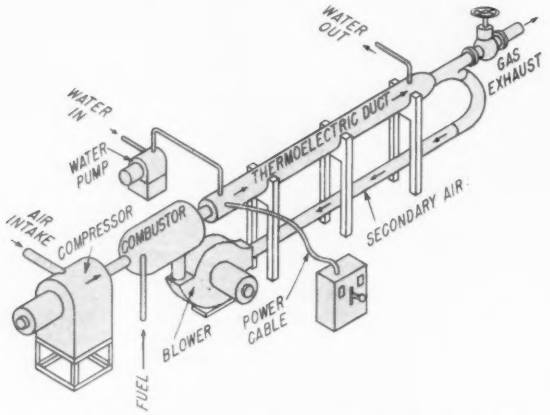
3 Heated gas flows through duct made of thermocouples while cooling water flows through annular space around the couples

How two 6.7-kw thermoelectric generators compare for varying gas-pressure ratios

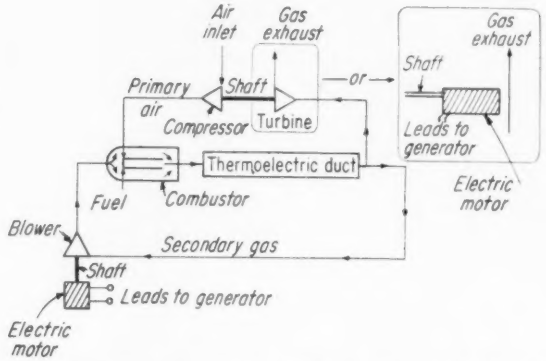
Plant factors	Gas-pressure ratio	$\frac{P}{Q}$	Plant volume, cu ft per kw	Plant weight, lb per kw
T_h = 1200 F	1	3.17	11.30	303
E_c = 0.67	2	3.40	5.50	192
E_{tc} = 0.063	3	3.51	3.69	136
T_h = 1470 F	1	6.45	3.50	116
E_c = 0.70	2	6.90	2.36	86
E_{tc} = 0.125	3	7.13	1.99	75



4 Open-cycle fuel-fired thermoelectric generator consists essentially of an air blower, combustor and thermoelectric duct



5 Closed-loop thermoelectric generator recirculates some of the exhaust gas to raise overall thermal efficiency of the unit



6 Thermoelectric generator can use a gas turbine to drive the primary air compressor for pressurizing unit's closed loop

legs can be varied. Since each thermocouple has a certain resistance to heat flow through it, and this resistance depends on its area-to-length ratio, we can vary the thermal resistance of each stage and determine the drop in hot-gas temperature. This determines the drop in hot-junction temperature.

The hot-junction temperature for each stage determines the Carnot and thermocouple efficiencies to fix the stage thermal efficiency. Thermal resistances of the individual stages can be adjusted so total power output is maximized for a given gas-flow rate and inlet-gas temperature.

An optimization analysis starts with given conditions of: (a) thermal-input rate in terms of mass flow rate m and inlet-gas temperature T_0 (b) coolant temperature T_a (c) thermoelectric duct diameter D and length L. With this data the thermoelectric elements can be designed to yield maximum electric output.

Fig. 4 shows that since power from some source must be supplied to drive the blower, all generator's power output is not available for the load. We can tap the generator output to power the blower and optimize net available power from the generator as we do next.

Closed-cycle generator shown in Fig. 5 and 6 uses the hot exhaust gas to reduce the fuel input to the combustor by recovering some waste heat. This will be profitable if blower consumption does not offset gain in cycle efficiency.

The available power P_a of the cycle equals the optimum power from the generator P^* less the blower power P_b. We must now determine m, D and L to maximize P_a. Analysis shows that P_a can only be optimized with respect to m and L, implying that these equations are satisfied simultaneously:

$$\frac{\delta P_a}{\delta m} = \frac{\delta P_a}{\delta L} = 0 \qquad (6)$$

An optimization analysis is made

with given conditions: (a) maximum operating temperature and corresponding thermocouple efficiency (b) ambient conditions with water-cooled cold junctions (c) duct diameter D (d) loop pressure P (e) thermoelectric elements designed for optimum power according to equation (6). The analysis then shows: (a) inlet-gas temperature T_0 that will not exceed maximum allowable thermocouple temperature (b) optimum flow rate m (c) optimum duct length L (d) optimum power P_a.

Two generator designs to produce 6.7-kw net output were studied. One plant has thermoelectric materials with an efficiency of 6.3% and a maximum hot-junction temperature of 1200 F. Other plant uses thermoelectric materials with an efficiency of 12.5% and a maximum hot-junction temperature of 1470 F.

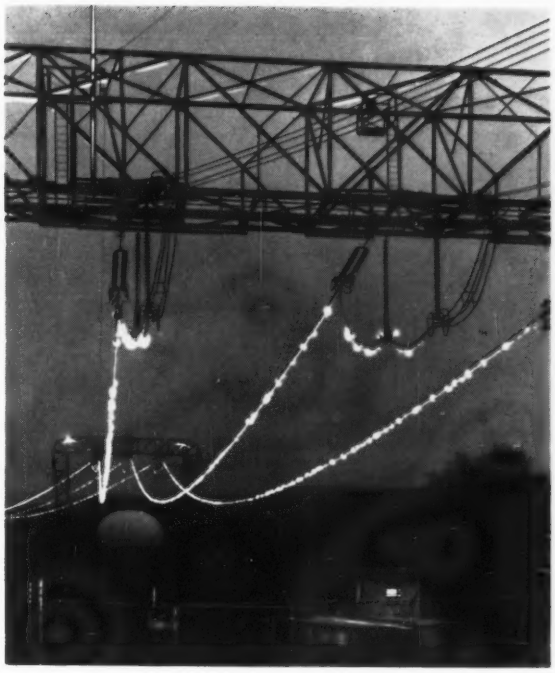
Table, left, gives the optimum thermal efficiencies and plant specific volumes and weights. These include the thermoelectric duct, piping, foundation, water pump, starter, battery, fuel pump, burner, air blower and motor, duct blower and motor and a 3-hr fuel supply. Fuel accounts for about 5 to 10% of volume and weight.

The table shows that pressurizing the loop improves the thermal efficiency and lowers the volume and weight for both plants. More importantly, improving thermoelectric efficiency markedly improves thermal efficiency and both specific weight and specific volume. This implies that as better materials are developed, more-compact generators of higher efficiency can be built.

We also found that raising the power rating of a plant lowers both specific volume and weight. We can expect a 67-kw plant to have lower weight and volume than ten 6.7-kw plants.

The two designs in the table show what can be done with present materials for this type of plant. Future improvement of thermoelectric materials offers a hopeful prospect for thermoelectric plants for special applications.

Research work leading to the preparation of this article was sponsored by the U.S. Navy Bureau of Ships.



EHV line energized at 750 kv

General Electric Company has energized its Project Extra-High-Voltage (EHV) at its outdoor laboratory just south of Pittsfield, Mass. The 4.3-mile transmission line will run in a range of 460 to 750 kv during the next few years. Photo, above, shows conductors arranged for 460 kv energized at 750 kv, producing a spectacular corona discharge that will be minimized as work progresses.

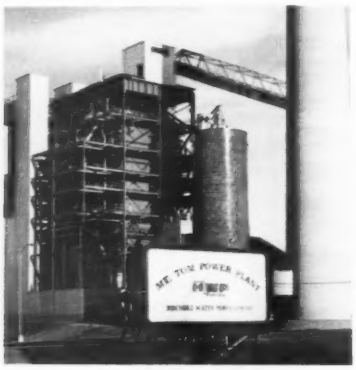
The project aims at raising transmission economy—one 750-kv line can transmit more than 36 times the energy carried by an equivalent 115-kv line. GE will put up about $6.2 million of the $7.5-million cost. Remainder will be contributed by six cooperating companies. Another six companies are supplying material for the southern section of the line, to be completed in mid-1961.

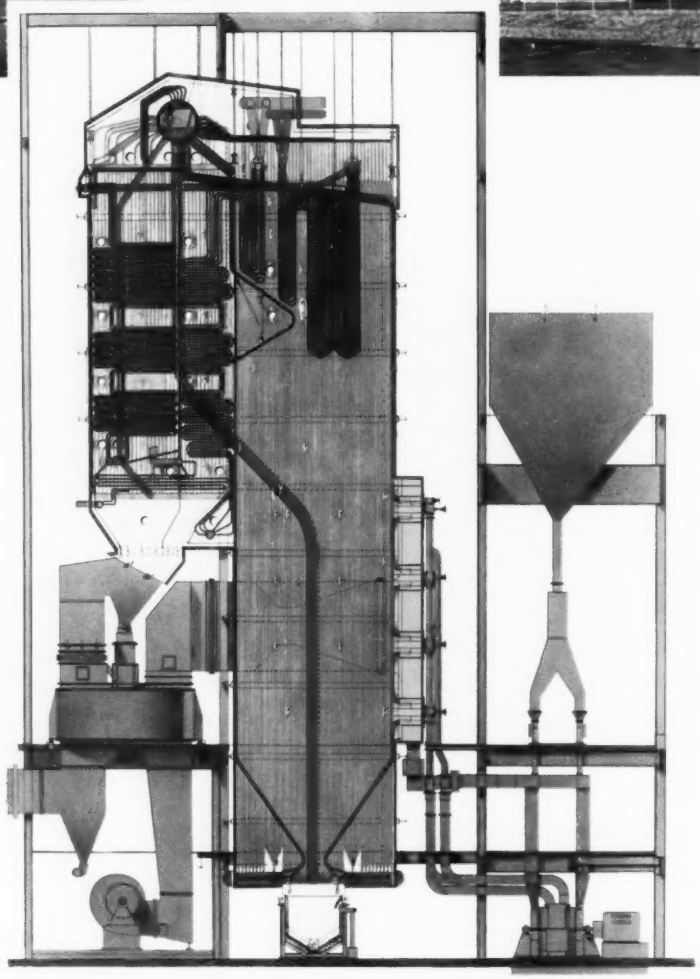
For assistance, GE can call on an Advisory Council of executives and engineers from 15 U. S. and Canadian utilities and a Consulting Engineers Committee representing 14 consulting firms. Over 260 measurements will be made, including radio and television influence, voltage surges and current, line tension, swing and vibrations, corona loss.

MOUNT TOM POWER PLANT

Holyoke Water Power Company

Mount Tom Power Plant, paradoxically located in a region rich in ancient geological formation and prehistoric lore, is a symbol of modern American engineering achievement. The Riley Boiler is one of the most northern boilers in New England featuring outdoor construction.





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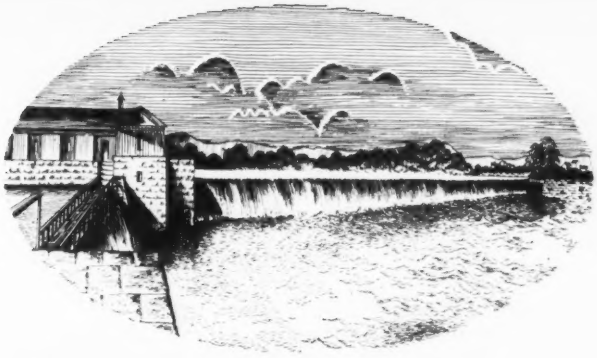

Holyoke Water Power Company Installs a 950,000 lb/hr RILEY Outdoor Type Reheat Boiler at Mt. Tom

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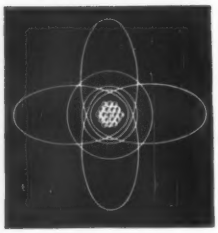

Nuclear notes

By B G A SKROTZKI, Associate Editor

Explosion in SLP-1 (Stationary Low Power Reactor No. 1) at the National Reactor Testing Station near Idaho Falls, Idaho killed three Army technicians at 9:02 pm on Jan 4, 1961. Early reports say the reactor core and vessel exploded killing the men on the plant operating floor. Authorities speculate that a chemical explosion took place between overheated aluminum cladding of the fuel elements and the reactor coolant. The building became radioactive to the extent that only one body could be recovered on the first day. Reactor was rated at 3 mwt and evaporated 9000 lb of 300-psig saturated steam per hr; turbine generated 200 kw, rest of the steam produced 400 kw of space heating. The reactor was fueled with 91% enriched UAlNi plates.

Progress report by Dr F K Pittman, Director of AEC's Division of Reactor Development, says that available evidence shows uranium oxide can stand long exposures with a possible upper limit of 60,000 to 70,000 megawatt days per ton—about a 7 to 8% burnup. He believes it possible to provide metallic fuel elements for over 1200-F operating temperature.

Shippingport reactor, according to Pittman, had its first seed fuel elements removed after 5808 equivalent full-power hours during which it generated 388,500 mwhre. In May 1960 the replacement seed was brought to full-power operation. On Dec 14, 1960 the UO_2 blanket had an average burnup of 2800 mwd per ton, the highest ever achieved. Blanket is expected to work satisfactorily through the third seed to be installed in mid-1961. The reactor generated about 620,350 mwhre to Dec 14, 1960.

Reactor-project costs for U.S. power prototypes under construction or design as of Sept 30, 1960 were estimated at $789.5 million of which $326.3 million will be spent by AEC and $463.2 million by the electric utilities. Amount spent up to Sept 30, 1960: $146.1 million by AEC and $232.1 million by electric utilities.

Homogeneous Reactor Experiment No. 2 at the Oak Ridge National Laboratory is now running at 2.6 mwt. Reversal of flow through the reactor seems to have greatly improved its performance.

Gas-centrifuge process ultimately can be used to separate U-235 from U-238 to produce weapons-grade materials according to AEC. Highly industrialized countries might perfect the method in about eight years. Process will use thousands of centrifuges costing several thousand dollars each, and have low power needs compared to present gas-diffusion methods. Enough U-235 might be produced for one crude weapon a year. Development will have to work along these lines: (1) proving reliability of present experimental machines for long-term service with uranium hexafluoride (2) centrifuge model satisfactory for mass production (3) method for inducting and removing gas from grouped centrifuges (4) auxiliary processes, services and instrumentation. AEC resumed research on centrifuge in 1953, now spends $2 to $3 million annually on its research and development. All work is classified.

Transatom Bulletin is published by Transatom central information office of European Atomic Energy Community in Brussels, Belgium, monthly starting Dec 1960. Euratom, United Kingdom AEC and USAEC are pooling efforts to produce translations of nuclear literature in all languages. Annual subscription will cost $8.00.

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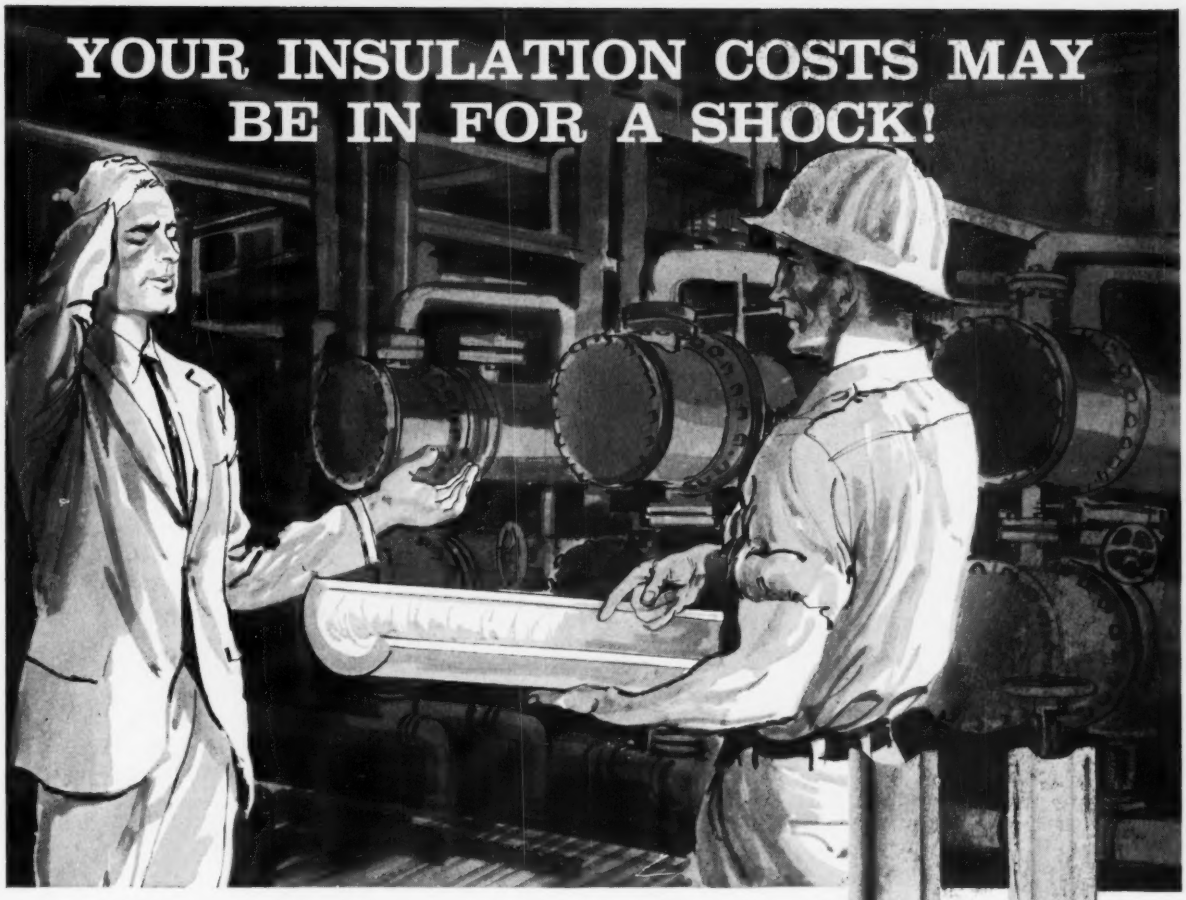

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Reserved for your comment

BOB BELLAS, Associate Editor

EDITOR'S NOTE: *The mails continue to pour in comments on our December 1960 48-p staff report,* Air Pollution. *In our January comment, pp 80 and 82, we published letters from people who are not regular readers of* POWER, *but, for obvious reasons, are concerned about air pollution. This month we present continued evidence that this report has made a worthwhile contribution toward a better understanding of these problems.*

. . . I was impressed by the excellent presentation of a complex subject. I have forwarded the report to the Air-Sanitation Program in the State Department of Health. I am sure they will find the material most interesting and useful.

Your publication is to be commended for its interest in the subject of air-pollution control.

ROBERT B MEYNER, *Governor*
State of New Jersey

. . . The information is certainly thought-provoking and you are to be commended for bringing to the attention of the people the danger of air pollution. That man is befouling the atmosphere in which he lives is evidenced when one glances from an airplane window on approaching almost any industrial city. Local authorities are facing a deep-rooted problem which I am sure your . . . efforts can help solve.

EDWIN B DOOLEY (*26th District, New York*)
U.S. House of Representatives

'Togetherness' is a must

Your special report on Air Pollution must be viewed as a significant contribution to the cause of air-pollution control. Restoration and maintenance of acceptable levels of air quality throughout the nation represents a new dimension in the age-old effort to construct healthful, prosperous and acceptable communities. As in other aspects of this effort, no single element of the community can accomplish this job alone. Instead, a synthesis of planning and action must take place between the several important elements of the community: the businessman-industrialist, the private citizen, the academician, the elected office-holder and the administrator.

There are mingled questions of fact and value surrounding the "clean-air movement" that must be recognized and resolved if satisfactory community action is ever to occur. Science can establish the casual relationships between contaminant emissions and some objective occurrence, but value judgments are necessary if these 'occurrences' are to be labeled "inconsequential" or "bad." It is this kind of value-resolution that inevitably lays the groundwork for any community air-pollution-control program. In short, we must determine the kind of community atmosphere in which we wish to live and work.

Necessarily, this basic step in a community air-pollution-control program requires an attitude of open-mindedness on the part of all community elements—a willingness to see the "other man's" point of view. Economics, esthetics, public nuisances, health . . . all of these considerations are important factors in fixing community-air-quality objectives. Your major thesis therefore is a good one. All of us—engineers and laymen, researchers and designers, private citizens and public officials—have an important role to play in the definition of air-pollution-control objectives.

And once a program is placed in operation, this requirement for cooperative interrelationships grows even stronger. The solution to any given source-emission problem almost always requires the attention of an entire range of people, including the designer, the builder, the operator, the plant air-pollution expert and the governmental inspector. Unless each of these individuals is fully attentive to the air-pollution requirement, along with the other usual considerations, an effective and economical air-pollution-control solution may be delayed or costly plant modifications may become necessary. The importance of these relationships has been clearly emphasized in your report, as well as the other important variables affecting community air quality. Congratulations on a job well done.

S SMITH GRISWOLD, *Air-Pollution-Control Officer*
Air-Pollution Control District
County of Los Angeles, Calif.

. . . The special report is clear, complete and authoritative; the solidest presentation in this field that I have seen—and I think I've seen them all. Congratulations on a magnificent piece of reporting and communicating.

R M BARSKY, *Public Information Officer*
Air-Pollution Control District
County of Los Angeles, Calif.

. . . It is an excellent job and you have every right to feel proud of your accomplishment. I do not recall ever seeing so much information and so much sense about air pollution packed into so few pages—and done with an interesting technique. Accept my compliments on a superb reporting job.

KENNETH KOWALD, *Secretary*
Department of Air-Pollution Control
City of New York, N. Y.

Minor disagreement, correction

. . . The story is a valuable addition to the literature on the subject. The technical phases are discussed in an interesting and informative manner. The public-relations aspects are covered realistically and well. The whole edition presents a compre-

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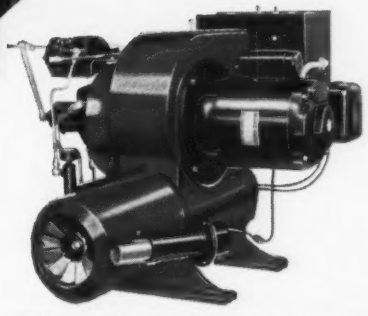

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hensive and practical program for approaching the problems of community air pollution. It should aid industry, public officials and the citizenry to profit by the experiences of areas where air pollution has become a serious problem, and to avoid some of the expensive mistakes which have been made in some situations.

One suggestion on a minor point of the report is offered. On p 80, under "home heating," there is an implication that combustion of fuel oils produces oxides of nitrogen and sulfur, but that gas as a fuel produces neither. Unhappily, gas fuel does produce oxides of nitrogen, as do all combustion processes. The emissions of NO from individual burners or heaters may be small, but community-wise the amount of NO can be significant. On the same page, under "domestic incineration," the statement "NO and other solids" might be misleading. Under normal conditions NO is an invisible gas.

Though POWER published data available to you when the report was being put together, the most recent estimates of the amounts of air pollution emitted by various sources in Los Angeles County differ somewhat from those shown in the table at the bottom of p 100, and which are also referred to on p 102 of the report. On an annual average basis, automobiles now contribute about 10,500 tons per day of pollutants (96% of the total), power-plant stacks contribute 240 tons or 2.2%, and the remaining 1.9% is attributed to miscellaneous other sources.

The publisher and editors of POWER are to be commended for preparing this comprehensive report, and for performing a valuable service to the public.

W L CHADWICK, *Vice-President*
Southern California Edison Co

Oversimplification

. . . I have not had an opportunity to go over the report in detail. . . . In general we think it will be extremely valuable to those who will read it. We are not able to tell you specifically what points we disagree with or the areas where more or less emphasis is needed. The overall organization of the material appears to follow a logical sequence.

It is our opinion that you have tried to cover too much of the subject of meteorology. Granted, meteorology is an extremely important phase of air pollution, but you have spent too much time and space on extraneous material. You should give more emphasis to the specific weather phenomena which directly relate to air pollution.

The idea of having simple diagrams to illustrate material in the text is certainly good. However, many of these illustrations should be improved or deleted since many of them are oversimplified to the point of being confusing. The writing style is certainly clear and easy to read, if a bit breezy. Some of the statements about physical and chemical occurrences tend to be oversimplified and may give the wrong impression.

The report is certainly worthy of thorough evaluation and we would like to give you our more-detailed comments in the near future.

JOHN E YOCOM, *Director of Technical Services*
Bay Area Air-Pollution Control District
San Francisco, Calif.

. . . I have read this with much interest. In addition to being a sound presentation of the multifaceted problem of air pollution and its control, it presents a clear and concise discussion of the earth's atmosphere and the influence of meteorology on air pollution. This is generally not available in a single piece of literature.

Congratulations on a fine presentation.

LEONARD GREENBURG MD, *Acting Chairman*
Dept of Preventive and Environmental Medicine
Albert Einstein College of Medicine
Yeshiva University

EDITOR'S NOTE: *Dr. Greenburg is the immediate Past-President of the Air-Pollution-Control Association and was Commissioner of New York City's Department of Air-Pollution Control from its inception in Nov 1952 until he resigned in Jan 1960 to take his present post at Yeshiva.*

. . . The report is splendid. It is interesting, constructive and instructive. The introduction to "Pollution and the community" on p 89 is particularly valuable, wherein you point out that "every community's problem is highly individual." The realization of this fact alone would certainly have prevented, and will in the future, air-pollution legislation that cannot be administered, and time and money spent for ill-advised control programs.

J L HODGES, *Chief*
Bureau of Smoke Abatement, Cleveland, Ohio

. . . Our staff has found the report to be an excellent factual summary of the air-pollution situation. The illustrations particularly will be of great value in our educational program designed to present the true situation to the public.

J D WHARTON MD, *Interim Director*
Dept of Public Health, State of Utah

Reprints of the 48-p report, Air Pollution, *are available from* POWER, *Reader Service Dept, 330 W 42nd St, New York 36, N. Y., for $1.00 a single copy. Discounts: 10%, 25%, 40% on orders of 10, 100, 1000 copies.*

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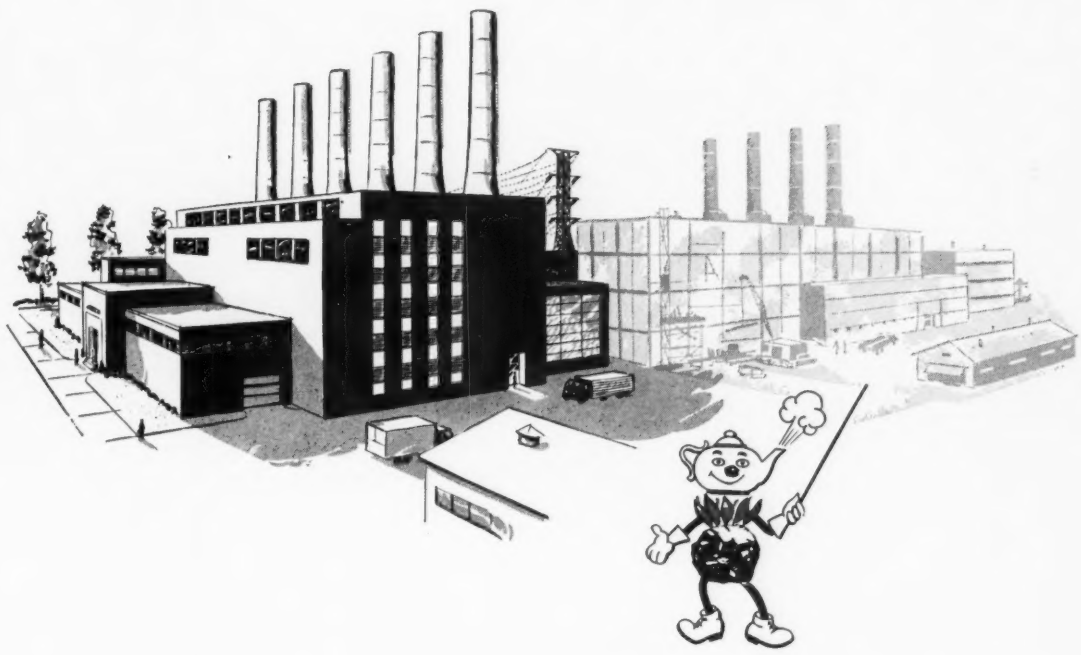

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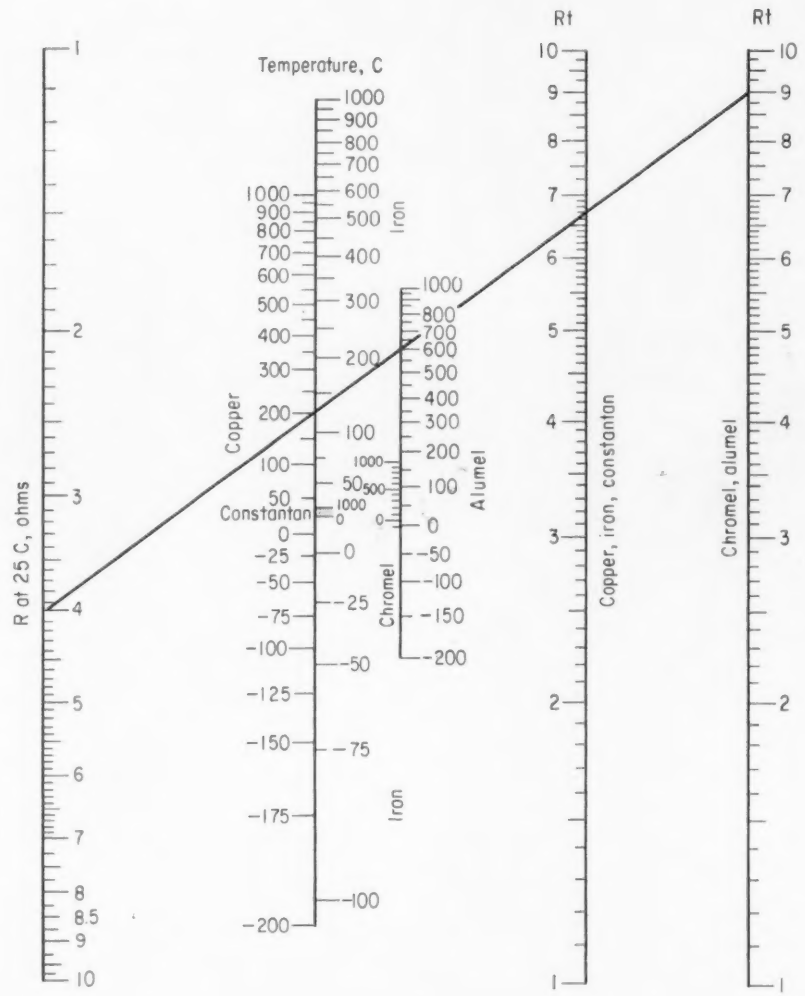
Power's data sheet

No. 342



Calculate change in resistance of thermocouple wire

Many thermocouples ultimately are used with and drive instruments of the D'Arsonval type. Other thermocouples appear in amplifier-servo networks. For either application you'll have to determine resistance of the thermocouple wire if you expect any degree of accuracy in measured temperatures. Using this nomogram eliminates complicated calculations and comparisons.

Nomogram helps figure changes in resistance of common thermocouples caused by temperature variations. Resistance at any temperature can be arrived at by knowing resistance at standard calibration temperature of 25 C; or by measuring resistance at a known temperature the standard resistance can be found. Nomogram is based on general equation: $R_{t2} = R_{t1}\,[1 - a_{t1}\,(t_2 - t_1)]$ Where R_{t1} = resistance at temperature t_1, R_{t2} = resistance at any other temperature and a_{t1} = temperature coefficient at t_1 (usually 25 C).

Example: Resistance of a short length of alumel wire is 4 ohms at 25 C. What will its resistance be at 600 C? Solution: Extend a line from 4 on the 25-C reference scale through 600 on the alumel scale. Read answer of 9 ohms on R_{t2} scale for alumel.

Range of this nomogram may be extended by multiplying both 25-C reference and R_t scales by factors of 10. That is, alumel wire of 40 ohms at 25 C will offer 90-ohms resistance at 600 C.—S J Salva, *Jackson, Mich.*

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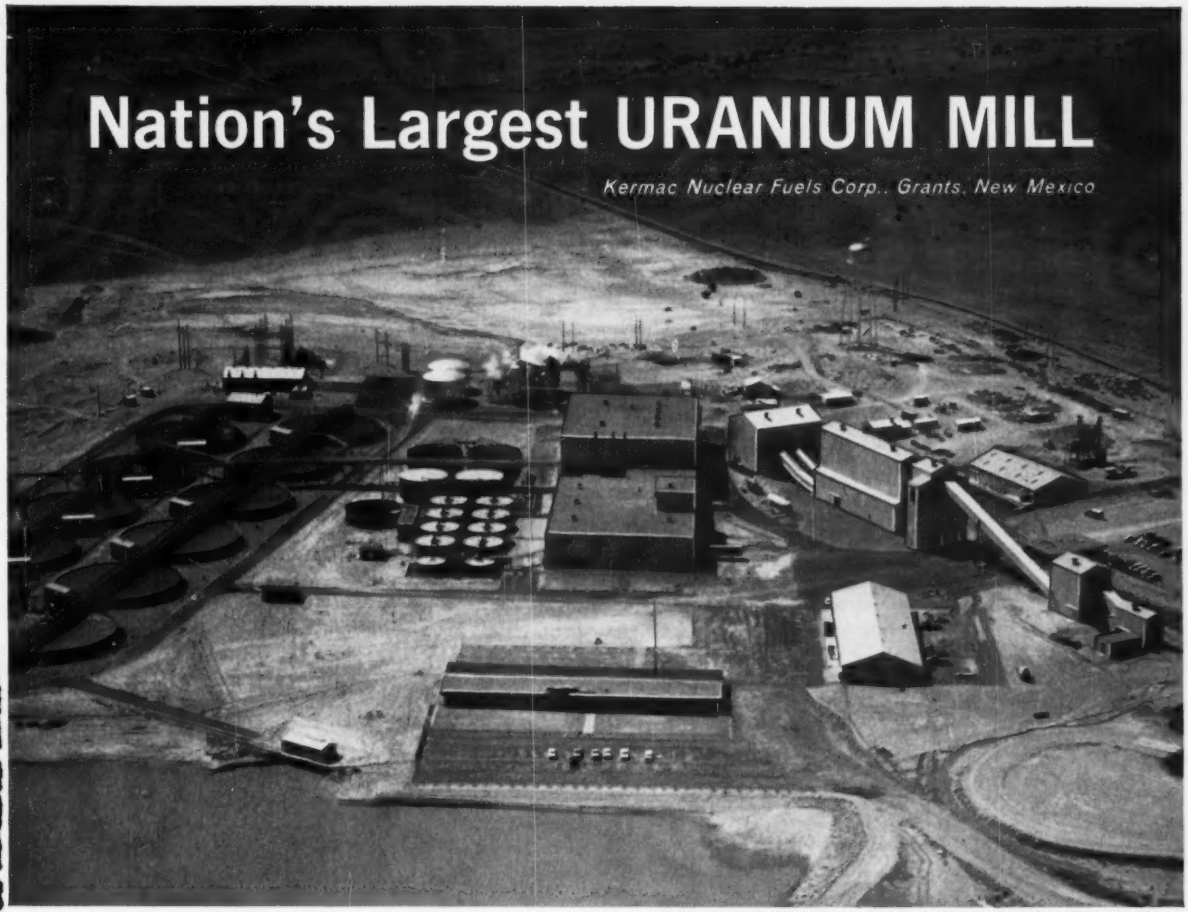

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In the processing, ore and its many derivative components are put through so many washing operations that the mill might be termed the world's biggest "laundry". The valves controlling the use of plant process water are in continuous service.

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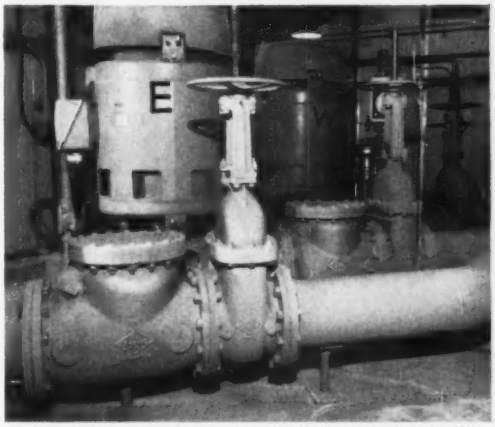

Jenkins Valves control process water to the rod mill, classifier sections and the acid plant. Also, lines in power house and heating system.

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Technical briefs . . . Latest engineering

ASME winter annual meeting reviews ten years' progress in management development

Management's past—a guide to its future, *L M Gilbreth, Gilbreth, Inc and W J Jaffe, Newark College of Engineering*
Management's beginnings can be traced to earliest Bible history—forecasting and planning in Joseph's interpretation of Pharaoh's dream (*Gen 46:15-43*). But modern industrial management got its real start with Taylor, Gantt and F Gilbreth. Their work is carefully traced as a foundation for further study.

Defining management has always been difficult. One of the best definitions is an ASME one often abbreviated into the "art of getting work done."

In addition to an excellent historical outline, authors plead for understanding of management principles here and abroad. *ASME 60-WA-67*

The philosophy of management, *L Urwick, Urwick House, London, England*
This objective study of American management progress is made possible largely by the author's vantage point. To many Americans his views will be extremely provocative; he separates the woods from the trees.

Growth in formal business-administration education has been nothing less than phenominal. In 1898 only one U.S. university offered such a course —today there are about 600.

Professionalism in management raises many questions. To illustrate but one, author quotes Lewis and Maude: "The professional man is conservative and cautious by nature; the businessman ought to (but now so seldom does!) think in terms of bold innovation—he must rush in wherever money can be made."

Management terms sorely need clarification. Example: While a board of directors is supposed to have a legislative or policy-making function, it rarely does today. In at least one large U.S. corporation it appears that the term *operating* has been substituted for the word *executive*, and *executive* has moved up a step and turned into a title of status for those who in fact do the policy making and perform the central administrative function. This leads to the present "semantic swamp" —an unhealthy condition. As Haldane observed more than 30 years ago, "mechanics became a science when physicists had decided what they meant by such words as weight, velocity and force, *but not till then. ASME 60-WA-55*

Philosophy of management, *A M Lederer, A M Lederer and Company, New York*
Because no generally accepted philosophy of management has as yet been formulated, no philosophy actually exists, so of course it cannot have progressed during the past decade. The search for a philosophy has bogged down in a morass of confused terms. Both *management* and *philosophy* are subject to a wide variety of interpretations.

Both terms are examined in depth, their historical and full meanings revealed. Based on this foundation, author hopes a true *philosophy of management* can now be developed. Only then can the real managerial revolution begin, giving meaning to the present search. *ASME 60-WA-56*

Management as a profession, *H F Smiddy, General Electric Company*
This status report covers the past, present and future of management as a profession. It draws heavily on quoted statements of leaders in the field to support the professional concept.

Progress in the 50's which will guide the efforts of the 60's is detailed. We've made a start toward genuine decentralization of responsibility in professional management. Although somewhat controversial, this has eliminated "coordinators" and "assistants to."

Evolution of management involves three basic phases: (1) multiplying human muscle output (2) multiplying human skills (3) multiplying mental output. First phase is quite progressed, second has made a good beginning, third is only at the threshold—but potentially is the most exciting.

Many of the fringe factors influencing the management profession are detailed. These include public acceptance, effect of dual corporate and professional responsibilities and maintenance of individual freedom. *ASME 60-WA-61*

Training

Training of power-plant personnel, *M F Ginter, The Dow Chemical Company*
Plant growth in size and complexity had, by 1940, convinced Dow Chemical that voluntary training programs were inadequate. By 1944 an agreement was reached with the union which stipulated training as a prerequisite for advancement.

So a full-time instructor took over all training in the power dept and produced tailor-made texts to fit all power-plant equipment. Visual aids played an important part in the program; photos of actual plant equipment were most successful. 225 men took part in 2-hr-per-week sessions with *equal time*

devoted to off-the-job study. Maintenance training used equipment-manufacturers' engineers. Control and instrument training was the most formal part of the entire program—600 hr of classroom work, again with equal time in off-the-job study.

Program experience produced these conclusions: (1) actual things the men work with are easier to "sell" for training programs (2) operation training should aim at equipment used—no frills (3) maintenance, instrument and control are hardest courses to run and sell (4) formal training courses can be intermittent (5) refresher courses on new equipment are a must and (6) training pays a generous return on every dollar. *TAPPI, Oct 1960*

Power-plant operator training, *J W Harrington, The Buckeye Cellulose Corp*
"Steam and power auxiliary operator" is the lowest classification in the power plant and covers new men coming into the department. Their training program includes both formal and on-the-job work.

First step is a specially prepared text in loose-leaf form covering (1) job description (2) outline and time schedule (3) training questions (4) notes and sketches (5) safety rules. Then the trainee works directly with an operator and spends one hr per day with the shift foreman. During the 2-week training program several conferences in the head office bring out individual training needs.

Measure of effectiveness: whenever emergency situations have arisen in the power plant, operators work smoothly and efficiently as a team. Outage and production losses stay low. *TAPPI, Oct 1960*

Developing the scale model for factory construction and maintenance, *M T Cutrell, Proctor and Gamble Company*
Use of models in plant construction and maintenance can be justified on the basis of savings in engineering work. Field use of models and dimensioned photos of these models give construction men a clearer picture of the job.

In small plants where full-time model makers can't be justified, a carefully selected draftsman can be trained inexpensively. This draftsman-modeler can then handle all plant modeling chores. His shop should be located close to the engineering office for convenience. Shop's equipment list must be complete for maximum benefit and model-production savings. But light-duty shop tools are all that are needed.

At Proctor & Gamble's Dallas plant, model training of a selected draftsman cost less than $1000 and shop equipment was installed complete for only $543. Equipment list shows tools and sources. Costs of specific modeling jobs shows relation to total job costs. In each case, advantages and disadvantages of models are given. *ASME 60-WA-267*

Directions for ordering these papers on page 102

Efficiency

A look at big-power cycles for 40% thermal efficiency or better, *P H Knowlton Jr, General Electric Company*
Thermal efficiency in large central power plants has marched steadily upward (from 25 to 40%) during the past 40 years. There have been brief plateaus, but the march has always quickly resumed. Today, at 40%, we stand at a point where further improvement in the steam cycle alone—through increased pressure and temperature—is probably impractical because of high initial costs which exceed economic worth. For the present, we can't do much better.

But many interesting combinations exist which promise continuing thermal-efficiency gains: (1) binary-vapor cycles (2) hot-gas-steam combined cycles (3) hot-gas cycles alone (4) fuel cells (5) thermoelectric devices (6) thermionic devices. Some, like the binary cycle, are old and proved; some are new and commercially untried—magnetohydrodynamic cycles—but all are potentially capable of breaking through today's 40%-thermal-efficiency ceiling.

In each case, theoretical and practical efficiencies are compared to Carnot-cycle efficiencies for the same operating conditions. And this base also provides a way to compare various methods discussed. *ASME 60-PWR-4*

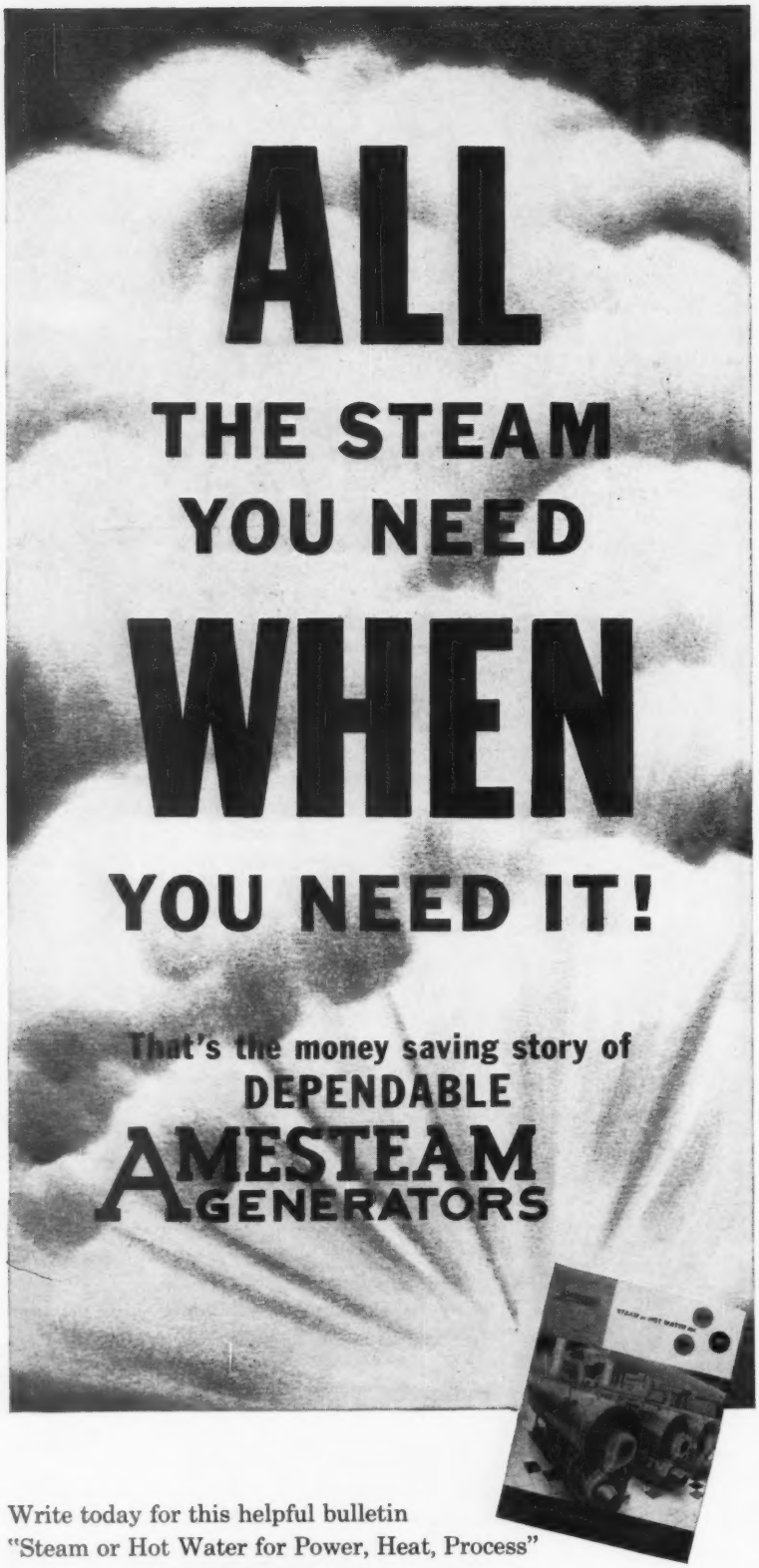
Standards

Standards of the National Electrical Manufacturers Association for resistance-welder control equipment have been revised. New standard—*Resistance Welding Control, IC-2-1960*—includes definitions and cycle diagrams for all generally used resistance-welding processes, cross referenced with a master table listing NEMA identification numbers for the control equipment required to perform each described function. All major control manufacturers list this equipment by NEMA number as well as their own model or type number.

Also listed: minimum standards for such factors as accuracy, time range, size and capacity which are widely used in the industry. Separate sections include frequency-converter controls, gun-welder controls and multifunction-process timers.

This revision will aid all users of the resistance-welding process to select proper control equipment for any job. *NEMA*

continued



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Technical briefs

Standards of the Hydraulic Institute have been revised to include new definitions and clarification of drawings, nomenclature and text. Other changes cover shaft-extension dimensions for NEMA Type-P vertical solid-shaft motors, npsh charts for centrifugal hot-water pumps (single and double suction), test code for centrifugal pumps and volumetric-efficiency calculations for reciprocating pumps using compressibility factors for H_2O and hydrocarbons. *HI*

Following new and revised publications are available from National Electrical Manufacturers Assn, 155 E 44th St, New York 17, N. Y.

Room air conditioners (*CN1-1960*). A cooling-load esimate form has been added which does not require specific conditions of inside temperature and humidity. Publication also contains definitions, rating standards and test procedures for room air conditioners. 30c.

Instrument transformers (*EI2-1960*). Type VIII metering-current transformers have been added for outdoor applications, 200 to 800 amp. Changes have been made in the dimensions of types I and V. Also covered: indoor potential transformers, metering-current transformers for primary circuits and instructions on care and operation of instrument transformers. 50c.

Transformers, regulators and reactors (*TR1-1960*). This revision includes general standards, test-code, terminology and apparatus standards for distribution, power and regulating transformers and special-purpose transformers such as used in unit substations, electric-arc furnaces and industrial rectifiers. By reference it includes other NEMA and ASA publications. $1.00.

American Standard requirements for varnished-cloth insulated cables. (*WC4-1960*). This ASA-IPCEA-NEMA joint publication applies to all sizes and classes of underground, aerial and indoor power

Begins on page 98

cables insulated with varnished cloth. Information covered: insulation, shielding, assembly of core, outer coverings, testing, shipping and installation. $2.00.

EEI-NEMA standards for voltage classification of luminaires used in street and highway lighting. (*SH3-1960*). 25c.

Maintenance

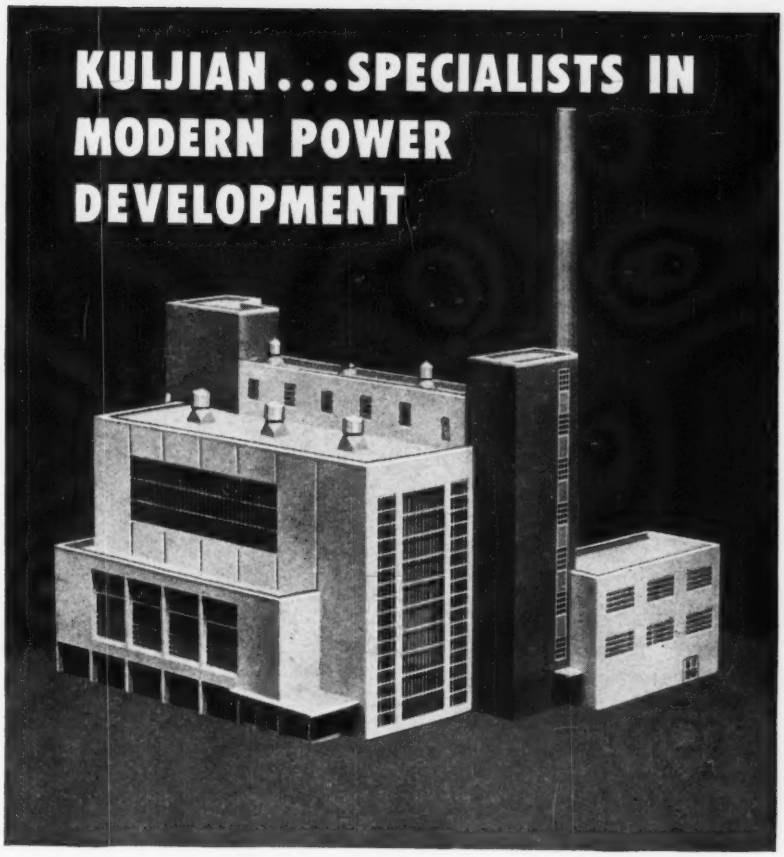
Electrical-system maintenance, *F J Hrabak, Reliance Electric and Engineering Company*

Factors involved in electric-system maintenance are three: planning, parts, people. Planning steps can only be as effective as the records kept. Then needs in terms of parts and people can be accurately forecast. Overstocking of parts and too many people can be just as wasteful as a shortage of either. Training is a must. It has been said that in mechanical repair work, 10% of the time is diagnosis and 90% actual repair work. In electrical maintenance these percentages are often reversed, highlighting the need for high diagnostic skill. Training is the answer here.

Preventive maintenance is also a large step in planning. For electric motors it must include certain specific areas: (1) brushes and commutators (2) bearings (3) windings and insulation (4) environmental conditions and (5) contactor tips. Each area is covered in detail to show what to watch for and means of correction. *TAPPI, Oct 1960*

Flexible coupled motor-bearing design, application, installation and maintenance, *J F Fenske, Allis-Chalmers Manufacturing Company*

Poor equipment alignment or improper coupling application can quickly produce disastrous sleeve-bearing failure in horizontal general-purpose motors. Calculated *expected* bearing life is practically infinite; it is the *unexpected* occurrence that causes failure. Example:



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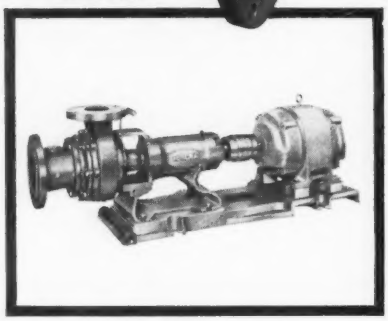

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Technical briefs

Begins on page 98

bearings are not designed for thrust loads. So when coupling misapplication imposes continuous and heavy thrust loads, bearing failure is certain.

Some coupling types can actually generalize a thrust force within themselves if alignment isn't perfect, but limited-end-float provision built into the coupling transmits this thrust to the *driven* equipment which has adequate thrust capacity. This protects the *driver* bearings. Other coupling designs have inherent end-float-limiting feature—any pull away from dead center builds up an opposite reaction in the coupling itself.

Importance of continued good alignment (especially when operating temperatures change) is stressed. NEMA-recommended bearing types and end floats are listed by motor hp and speed. *TAPPI, Oct 1960*

To obtain complete text

Material for these abstracts comes from the following sources. Order complete paper from source, *not* POWER.

ASME. Contact American Society of Mechanical Engineers, 29 W 39th St, New York 18, N. Y. Members, 50c; nonmembers, $1.00.

TAPPI. Papers will appear in *TAPPI Magazine.* Contact Technical Association, Pulp and Paper Industry, 360 Lexington Ave, New York 17, N. Y.

HI. Contact Hydraulic Institute, 122 E 42nd St, New York 17, N. Y. Price (revision only):

NEMA. Contact National Electrical Manufacturers Association, 155 E 44th St, New York 17, N. Y. Price: $1.00.

Erection of a 160-ft-dia steel sphere which will house Europe's largest boiling-water reactor is underway at the nuclear-plant site on the Garigliano River north of Naples.

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Either of the no-postage Reader Service cards below and p 103B. will bring you information an any new equipment listed or product advertised, plus new literature for your files

- **Study New Equipment** described in this issue starting on p 112. Circle numbers on card corresponding to items listed
- **Check New Literature** available this month beginning on p 103A. To get your personal copies use the card below
- **Read advertisements** and note number listed under each ad. Circle ad numbers on card for complete details
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PLANT EQUIPMENT in the news this month, starting on p 112

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SEARCHLIGHT SECTION for used and rebuilt equipment, starting on p 195

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New free literature

General equipment and key materials for systems engineering

• **Welding plastics**

101 **Operating and maintenance** instructions for welding plastics are given in 4-p manual 60-2. Hand, medium- and high-speed welding are described. Kamlar Products Company

102 **Welders** for thermoplastics are shown in bulletin 60-1. Special tips and tools are also included. Kamlar Products Company

• **Maintenance**

103 **Ultrasonic-cleaning** hints and applications are contained in 12-p primer. Metal-cleaning principles are topic of one chapter. National Ultrasonic Corp

104 **Ultrasonic - cleaning** equipment catalog includes tips on purchasing equipment, lists cleaning compounds. Well-illustrated 24 pp give complete specifications and ordering information required. National Ultrasonic Corp

105 **Marker** used to indicate ellipses for cutting pipe or other curved or flat surfaces is explained in 4-p folder. Boyd Brothers & Sullivan

106 **Thawing pipe** with 1-v electricity: subject of bulletin EW-243. Contains instructions, lists equipment needed. Hobart Brothers Company

• **Heat exchangers**

107 **Double-pipe** heat exchangers, their installation and maintenance, are featured in 8-p guide 120. Parts and spare-parts inventories are itemized for each exchanger. Brown Fintube Co

108 **Fall-winter Review** contains an article on selecting materials for use in manufacturing heat exchangers. Graphs, charts and tables accompany article. Alco Products, Inc

• **Instruments**

109 **Portable pyrometer indicator** is topic of bulletin 0036. Gives performance specifications and standard calibrations for use with pyrometer. Atlantic Pyrometer, Inc

110 **Pressure regulator** for laboratory test applications is described in bulletin 113. Regulator has inlet pressures up to 1 psi and outlet pressures ranging from 3.2- to 16-in. H_2O. American Meter Company

111 **Temperature controls,** electric and pneumatic differential-expansion types handling up to

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Gas systems 106
Liquid-handling systems 106
Steam systems 108
Electrical systems 110

2000 F, are discussed in 4-p catalog G-25. Standard, watertight and explosionproof enclosures are covered. Burling Instrument Co

112 **Packaged control panels** for pumps, materials-handling and air-conditioning equipment are featured in 8-p bulletin GEA-6334A. Photos show panel components—starters, relays, switches and timers. General Electric Company

113 **Multiplexing system** expands to 600 channels for communication requirements—introduced in 12-p brochure. System is said to be practical for small or large users. Lynch Communication Systems Inc

114 **Analog computer,** storage type, is subject of 9-p report 80-105-008. Includes mathematical equations, diagrams, info on installation. Computer Systems, Inc

115 **Photoelectric** control unit is a combination of electronic timer and photoelectric scanner with ranges from 2 in. to 18 ft. Described in circular PE-7. Farmer Electric Products Company, Inc

116 **Bench scale,** platform type for heavy-duty industrial weighing, is discussed in bulletin 3415. The Exact Weight Scale Company

117 **Pyrometers** for flame and hot-gas temperature measurements above 3000 F are topics of bulletins 0054 and 0054.1. Atlantic Pyrometers, Inc

• **Valves, fittings and piping**

118 **Diaphragm-seal** pressure-snubber unit for sealed systems protects against corrosion and plugging—see 4-p brochure for full details. Chemiquip Company

119 **Transite pressure-pipe** installation guide TR-62A covers handling and installation of pipe in its 124 pp. Site conditions are also included. Johns-Manville Corp

120 **Flexible hoses** and ducts for moving air, dust, fumes and materials are described in 12-p bulletin 605. Selection, installation, prices are included. The Flexaust Company

121 **Flexible rubber pipe,** expansion joints, transmission and conveyor belts are subject of catalog M5. 24 pp include specs and ordering info. Raybestos-Manhattan, Inc, Manhattan Rubber Div

122 **Miniature filter chambers** with capacity of 5 to 7.5 gph are explained in bulletin 401. Sethco Manufacturing Corp

123 **Control valves,** sliding gate and plate in sizes from ¼ to 6 in., are objects of 8-p brochure J170-1. Recommended for steam, water,

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NEW FREE LITERATURE continued .....circle key numbers, page 103, for your copies

air, oil, gas and chemicals, valves are illustrated and charted in catalog. OPW-Jordan

124 **Pressure regulators** can be used for low-pressure pilot applications. Bulletin 103, American Meter Company

125 **Pilot regulators** using own output as control medium are features of bulletin 140. American Meter Company

126 **Valves,** their servicing and lubrication, are shown in step-by-step instructions in 8-p catalog V-218 Rev 2. Chart of recommended lubricants is included. Rockwell Manufacturing Company

127 **Tube fittings** of corrosion-resistant stainless steel are subject of 4-p folder 4323B1. Diagrams of shapes and size tables provide ordering information. Parker-Hannifin Corp

128 **Rubber pipe,** wire-reinforced to dampen vibration, is feature of 4-p bulletin 866. General Rubber Corporation

129 **Gate valves** large and small, designed specifically for ductile iron, are described in brochure 1011. 12 pp list specifications, pressure - temperature ratings and applications. The Ohio Injector Co

130 **Disposable filter cartridges** suitable for plating solutions, diesel fuels and chemical - process streams are topic of 4-p folder MW-100. The Cuno Engineering Corp

131 **Explosive valves** with reusable bodies and replacement kits, rated up to 5000 psi, are subject of 4-p bulletin 1160 XV. Conax Corp

132 **Ductile fittings** and valves are described in 12-p catalog with designs, weights and comparison charts. One section compares ductile iron and other materials. Stockham Valves and Fittings

• Metals and materials

133 **Zinc-alloy die-casting** pointers are contained in compact 36-p booklet. Gives rules for die care and chapter on alloy and die temperatures. Henning Bros and Smith

134 **Custom-alloy** steel castings are described and illustrated in 24-p brochure 175 DS. Data on heat-, corrosion- and abrasion-resistant alloy steels is included. Esco Corp

135 **Extruded rectangles** for wear and abrasion applications are subject of 4-p circular G-50b. Ampco Metal, Inc

136 **Graphite** and carbon felts used for insulation, gas filtration and gasketing are covered in bulletin 104. National Carbon Company

137 **Magnesite-chrome basic brick** has dimpled metal jacket to provide built-in expansion—shown in literature from H K Porter Company, Inc, Refractories Div

138 **Extruded solid rounds** and rectangles, centrifugally cast bars, rolled sheet and plate produced from aluminum-bronze alloys are

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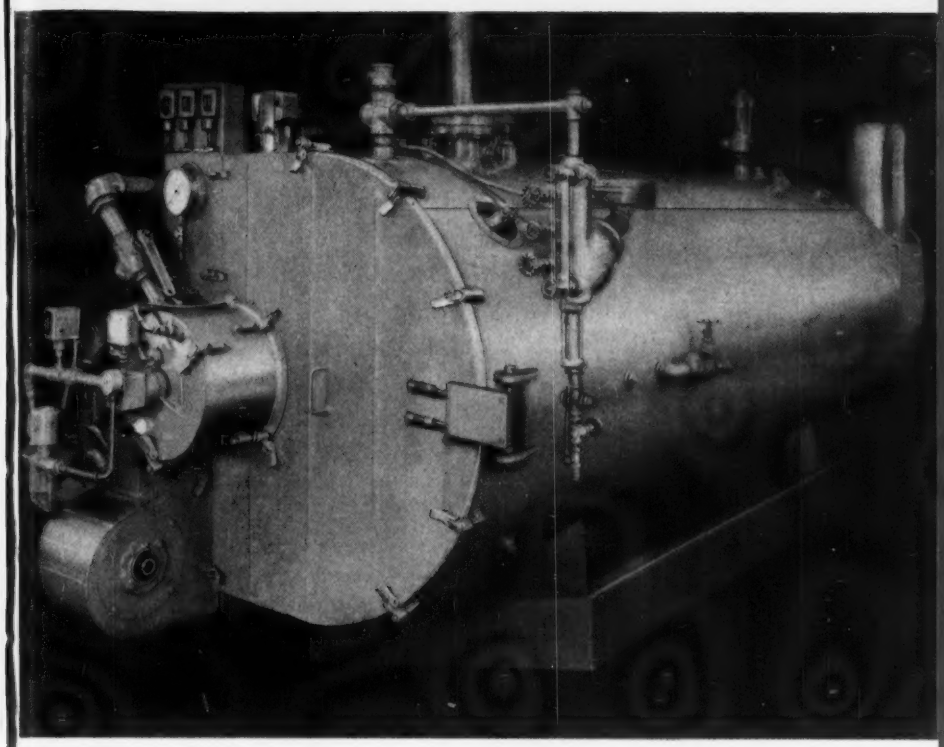

Introducing the *Powermaster*® Positive Flow® Boiler

...the greatest advance in packaged firetube boiler design in seven decades!

Here for the first time, is a packaged boiler that gives you an ease of operation, dependability and accessibility often hoped for but never before achieved!

The result of more than two years of development and testing, the *Powermaster Positive Flow* boiler has been tried, tested and proved by one of America's foremost consulting engineer firms. Among its many tried and proven features are: accelerated internal circulation which greatly improves heat absorption efficiency . . . *PyroFlow*® burner system which can be easily converted in the field from/to either oil or gas without burner modification . . . hinged front and rear covers . . . optional dryback or wetback construction . . . quieter operation.

No other boiler can match the performance of the Powermaster Model PF for generating steam or hot water economically and dependably. A comparison of performance tests with other boilers will prove this is no idle statement.

See a demonstration of this highly advanced boiler at the International Heating & Ventilating Exposition in Chicago, Feb. 13-16, Booth 207, or write for Bulletin No. 1275. A leasing arrangement may be made with your local O&S distributor.

ORR & SEMBOWER, INC.
850 Morgantown Road
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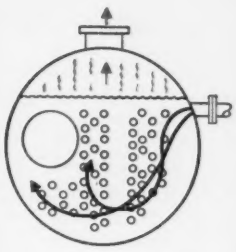
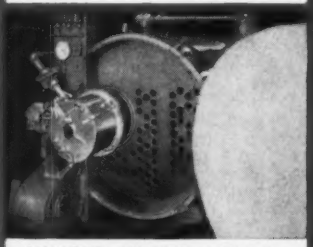
POSITIVE FLOW®
PACKAGED AUTOMATIC BOILERS

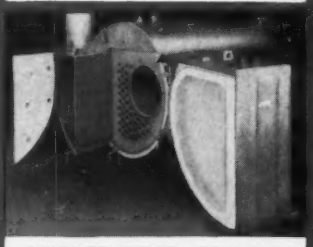


POSITIVE CIRCULATION
Design permits boiler feed injection and natural thermal circulation to augment each other. This provides the maximum water circulating rate and the most efficient form of heat transfer, **counterflow.**

SIDE LOCATED FURNACE
Side located furnace eliminates danger of heat damage due to stagnant water and sludge. Turn-around spaces are simple, accessible and positive sealed.

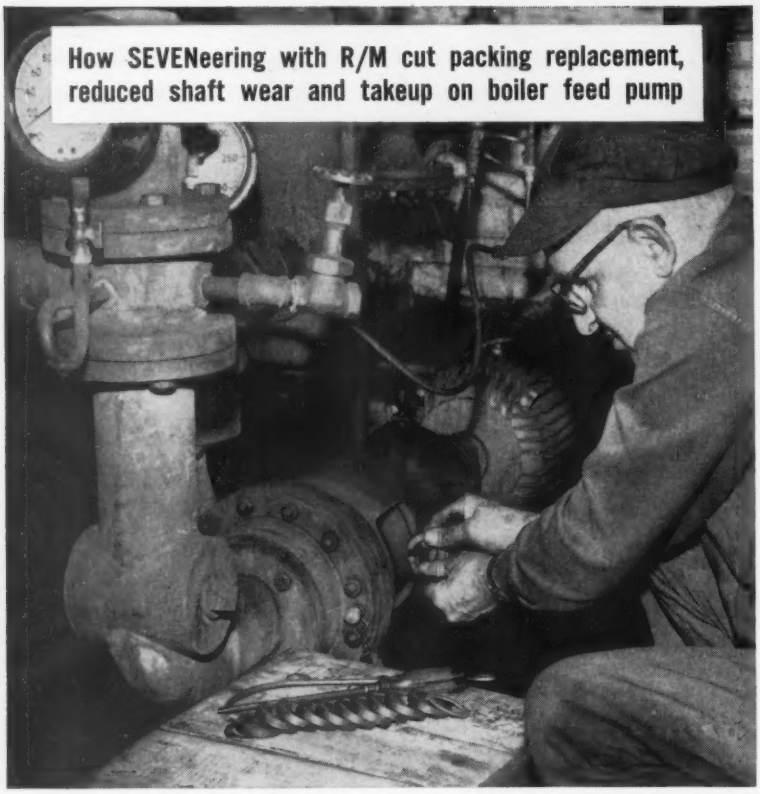


HINGED FRONT COVER
Hinged front cover, with quick-opening fasteners (no bolts) can be opened for access to heating surface without disturbing burner, wiring or piping.



DIVIDED REAR COVER
Hinged rear cover, also with quick-opening fasteners, permits ease of accessibility and maintenance. Each cover section forms a separate seal in a single plane, providing protection from short-circuiting of combustion gases. No internal baffles to leak.

For more facts circle 255 on Reader Service card, p 103



Only 2 repackings a year with R/M 1845 "versi-pak"® — more than 26 with former boiler feed pump packing

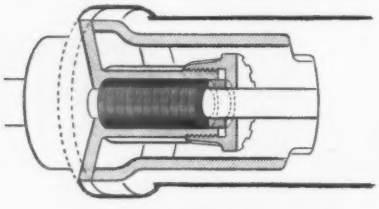
Poor packing life, expensive shaft wear, and constant takeup were all problems harassing the boiler room engineer at Ludlow Papers, Ware, Mass., in maintaining a boiler feed pump operating at 325-350°F and 3450 rpm.

The life of the braided asbestos packing formerly used was only 1-2 weeks, the shaft had to be replaced in less than a year, and too frequent packing takeup was necessary.

Maintenance Specialties Co., an R/M Big 7 Packing distributor, solved all problems fast with R/M 1845 "versi-pak" nonjacketed plastic packing. This Big 7 Type No. 1 Packing, made from long asbestos fibers combined with low-friction compounds and nonleaching lubricants, not only extended packing life to 5-6 months, but also resulted in negligible shaft wear and packing takeup. And R/M "versi-pak" costs less per set than the former packing.

Ludlow Papers, one of the largest manufacturers of gummed and coated label papers, specialty papers, reinforced papers and tapes, plastic film, and plastic coated materials, is one of many concerns Seveneering with R/M to meet their packing needs.

Our Big 7 Packing Selection Chart is a helpful guide to the selection and application of R/M Packings for all types of equipment. Write for your copy today. And the next time you need packings, see your authorized R/M Big 7 Packing distributor. He has the technical background and the packings to solve your knuckle-busting problems.



Ground-in lubrication, high resistance to heat, materials handled and pressure make R/M Big 7 Type No. 1 Packings ideal for pumps handling water, steam, chemicals, foods, beverages, oil and solvents.

R/M's Big 7 Packing Types meet 95% of all packing needs, are sold exclusively through authorized R/M distributors

RM **RAYBESTOS-MANHATTAN, INC.**
BIG 7 PACKINGS
PACKING DIVISION, PASSAIC, N.J.
MECHANICAL PACKINGS AND GASKET MATERIALS

Free literature

Begins on page 103A

some items mentioned in 4-p catalog G-51a. Ampco Metal, Inc

139 **Bronze die alloy** for drawing, forming and bending steels is featured in 4-p bulletin G-55. Typical applications are included. Ampco Metal, Inc

Liquid-handling systems

• Water treatment

140 **Coagulation chemistry** as applied to water treatment is discussed in 8-p illustrated brochure A-1. One topic: new process of in-line clarification. Nalco Chemical Company

• Controls

141 **Portable pH meters** measure over the full 0-to-14 pH range. Designed for plant, lab and field use, they're topic of bulletin 720-C. Beckman Instruments, Inc, Scientific and Process Instruments Div

142 **pH meter** for measuring liquids, pastes or semisolids is explained in catalog 706-F. Meter measures over 0-to-14 pH range and reads to ±1400 mv. Beckman Instruments, Inc, Scientific and Process Instruments Div

• Liquid

143 **Air and hydraulic** components are illustrated in 8-p selection and purchase guide 601. The Rucker Company

144 **Controlled-volume** motor-driven pumps are subject of well-illustrated 32-p catalog 553-2. Selection data guide and capacity-pressure tables are features. Milton Roy Company

145 **Vertical close-coupled** pumps, topic of 4-p folder, are compact—available in wide capacity and material ranges. Sempco Corp

Gas systems

• Compressors

146 **Packaged** high-pressure compressor systems for military, commercial, lab and pilot-plant use are illustrated and described in 8-p bulletin 189. Clark Bros Co

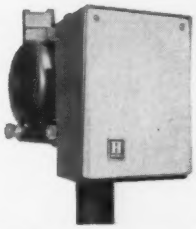
147 **Packaged air compressors,** 25 to 100 hp, are described in 6-p pamphlet 203. Dimensions, weights and specifications are included. Clark Bros Co

148 **Motor compressors,** 4- and 6-cylinder units, are topics of 4-p brochures 6001 and 6006. Compressors extend low-temperature range to 7½ and 10 hp. Copeland Refrigeration Corp

continued

NEW BELLOWS FLOW TRANSMITTER

gives you field indication plus convenience and precision



You get all the economy and convenience of pneumatic transmission and all the efficiency of the bellows meter body plus field indication, when needed, in the new Honeywell Bellows Flow Transmitter. Use it in any application to transmit flow or liquid level measurements in open or closed tanks.

This new meter has automatic ambient temperature compensation and two-way overload protection for 100% of span. Maintenance is greatly simplified by modular construction which lets you remove any major component by loosening two screws. All field adjustments are easily accessible, and a self-locking feature prevents upset after calibration adjustments are made.

You can change ranges in the field simply by removing a single spring assembly and replacing it with an assembly of the desired range . . . adjust damping quickly and accurately, while the instrument is in operation . . . install the meter with either vertical or horizontal piping, so that it vents, drains and purges itself. The meter transmits with calibrated accuracy of ±0.5% of full scale, and indicates within ±1.0% of full scale.

New Bellows Transmitter is available with a concentric scale or as a non-indicator. It has 16 ranges—from 0-10 inches of water to 0-400 inches of water.

For complete details on the new Bellows Flow Transmitter, call your nearby Honeywell field engineer. Or write MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.—In Canada, Honeywell Controls, Ltd., Toronto 17, Ontario.

Honeywell

First in Control

SINCE 1885

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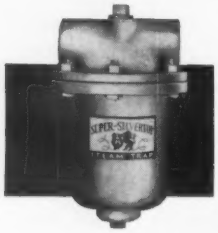

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INVERTED BUCKET TRAPS for:

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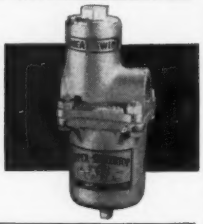
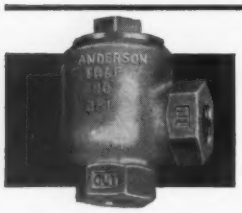
Calenders
Coffee Urns
Convectors
Corrugated Paper Making Machines
Drain Pans
Dress Forms
Drips
Dry Cans
Dryers
Fan Systems
Flat Work Ironers
Header Drips
Hot Water Heaters
Kettles
Pipe Coils
Presses
Sock Forms
Steam Engines
Steam Mains
Steam Tables
Steam Purifiers
Sterilizers
Submerged Surfaces
Tumblers
Unit Heaters
Vacuum Canners
Warmers

Heat-Kwik
COMBINATION TRAPS for:



Autoclaves
Cooking Kettles
Dryers
Expellers
Kettles
Rendering Cookers
Retorts
Slashers
Submerged Surfaces
Tempering Apparatus
Unit Heaters
Water Heaters

or wherever fast heating up is desired

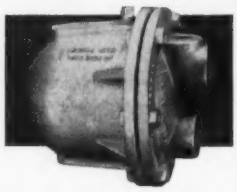


Quik-Flex
THERMOSTATIC STEAM TRAPS for:

Autoclaves
Cooking Kettles
Dryers
Expellers
Kettles
Retorts
Slashers
Sterilizers

or wherever fast heating up, or outside freeze-proof installations are required.

Anderson
FLOAT TRAPS for:



Air Purifiers
Gas Purifiers
Condensate Flow Meters
False Water Line Sewers
Master Trapping Separators
Air Separators
Gas Separators
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Gas Receivers
Gas Scrubbers

or wherever continuous discharge is necessary

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BY THE MANUFACTURERS OF Hi-eF PURIFIERS

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Free literature

Begins on page 103A

• **Accessory equipment**

149 **Actuators,** spring and diaphragm, are shown in different valve assemblies in 4-p bulletin B-1020-7. Conoflow Corp

150 **Dehydrators** prevent moisture from entering storage tanks. Their flow capacities, dimensions and installation are outlined in 6-p booklet 500-5-C. The Johnston and Jennings Co

151 **Air-control valves,** mechanically and manually operated, are charted in bulletin 60-1. Hoffman Valves, Inc

Steam systems

• **Boilers and controls**

152 **Check list** to help you keep your boiler clean is offered by Cleaver-Brooks Company

153 **Steam traps** are the subject of 10-p pamphlet T-1743. Capacities, dimensions, weights and prices are given. Yarnall-Waring Company

154 **Testing steam purity** by using ion-exchange resins in your sampling line results in more accurate conductivity readings. See 2-p circular 163 from Barnstead Still and Sterilizer Company

155 **Strainers,** thermostatic and expansion steam traps are illustrated and explained in 20-p catalog 400. One chapter helps determine proper size. W H Nicholson and Company

• **Filters and strainers**

156 **Filtering** steam condensate in supercritical generating stations: focal point of 8-p filter booklet. Croll-Reynolds Engineering Co

157 **Line strainer** guide J-LS for users or specifiers includes in its 4 pp tips for better performance. OPW-Jordan

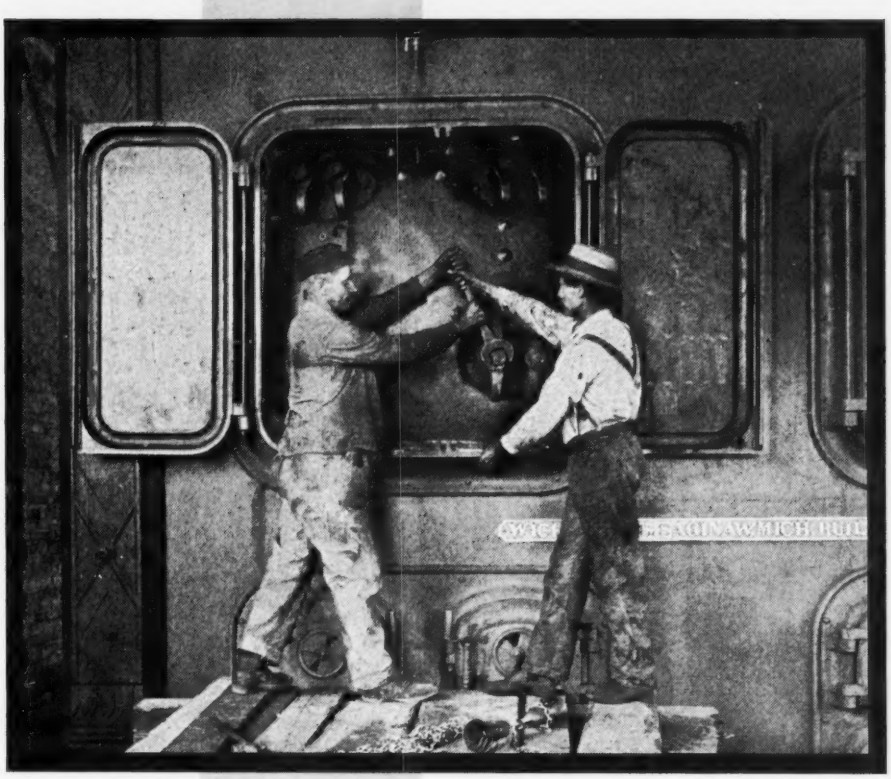
• **Materials handling**

158 **Roller chain** for conveyors is subject of catalog 760. Also included: sprockets and couplings. Diamond Chain Company, Inc

159 **Performance** of screw feeders tested on dry materials is described in 8-p folder. Rates of feeding range from 0.1 to 1000 lb per min depending on material. Vibra Screw Feeders, Inc

160 **Volumetric feeder** for measuring powdered, granular or lumpy solids has a maximum capacity of 3600 cu ft per hr. See 4-p bulletin 320.200 from Wallace & Tiernan Inc

continued

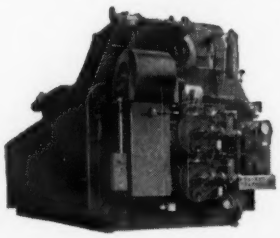


This boiler, built by Wickes Boiler Co. in 1875, operated satisfactorily for the next 31 years.

When buying modern Boiler Equipment it pays to deal with an *EXPERIENCED MANUFACTURER*

There is no substitute for experience. From the first pioneering days in boiler manufacture, years before the boiler pictured above was built, Wickes Boiler Co. has continued to be a world leader in the development of economical, efficient and dependable steam generators. Today, Wickes builds steam generators in sizes to 500,000 lbs. of steam per hour, for high or low steam pressures and temperatures and for all types of fuels and firing methods.

A Wickes steam generator, custom engineered to exact generating requirements, is built to the highest standards of workmanship, backed by over a century of boiler making experience.



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THE WICKES CORPORATION ESTABLISHED 1854

WICKES

175

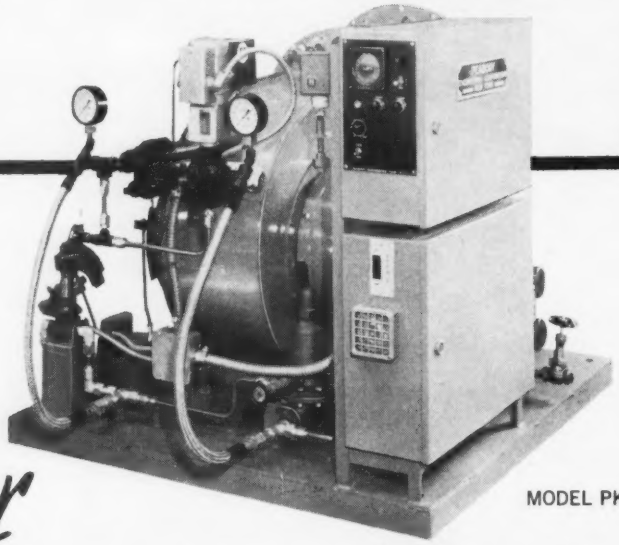
WICKES BOILER CO. DIVISION OF THE WICKES CORPORATION, SAGINAW 10, MICHIGAN

For more facts circle 259 on Reader Service card, p 103

FIELD-PROVEN

NEW PEABODY PKS and PKL

COMBINATION GAS AND OIL BURNERS



MODEL PKL

for

...Pressurized Furnace Package Boilers
...Conversion of Coal-Fired Boilers
...Process Furnaces

These *all new* automatic fuel burners, with completely interlocked sequence and safety circuits and unified fuel-air ratio control provide maximum security before start-up, during operation and after shutdown. They —

- Recirculate hot fuel oil • Test fuel oil temperature • Test fuel pressure
- Purge furnace with forced draft fan • Prove ignition...all before start-up!
- Ignite with gas-electric ignition
- Light off at low fire
- Operate quietly
- Burn gas or oil (No. 2 through No. 6 oil)
- Follow load demand
- Maintain efficient combustion at all loads
- Change over rapidly from one fuel to the other
- Shut down if load ceases
- Shut down in ONE Second and lock out on flame failure
- Purge furnace with forced draft fan after shutdown
- Relight automatically when load resumes or relight manually after flame failure but only after satisfying all safety requirements

These factory assembled and tested PK burners have no atomizer moving parts to get out of order. Their unique safety and control features provide the optimum in safe, dependable, efficient, clean, quiet operation — day in and day out. Write today for new Bulletin 431

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Free literature

Begins on page 103A

161 **Bucket** elevators for handling bulk materials are topic of 22-p booklet. Chapters deal with belt selection, splicing and trouble-shooting. Tables cover steel buckets. Hewitt-Robins Inc

Electrical systems

• Generation, transformation and conversion

162 **Brushless** inductor motor-generator makes 400-c power available for wide use. Specifications are in 4-p catalog from Leach Corp

163 **Rebuilding** distribution transformers is subject of 8-p brochure GEA-7108. Life span of transformers is charted and standard insulation system described. General Electric Company

164 **Medium transformers** and their insulation system: explained in 24-p bulletin GEA-6108D. Gives kva and voltage ratings for 501- to 5000-kva single-phase and 501- to 10,000-kva 3-phase units. General Electric Company

165 **Pad-mounted** distribution transformer is featured in quarterly publication. Voltage is encased in shielded and grounded compartment for safety. R T & E Corp

• Distribution and protection

166 **Trolley - busway** steel - enclosed electrification system is subject of 40-p bulletin 90. Special sections are included on installation planning, methods of mounting and application. Feedrail Corp

167 **Circuit breakers.** l-v current-limiting units with 200,000-amp interrupting capacity, are detailed in 10-p catalog 4300-1A. Includes selection, application and guide specs. I-T-E Circuit Breaker Company

• Application

168 **Secondary-control switchboards** with basic circuits—dimensions and components—are topic of 24-p well-illustrated brochure GED-4239. Applications for unit generator, transformer and power-transformer circuits are described. General Electric Company

169 **Gearmotors** and speed reducers are topics of 6-p bulletin MD-1. Gearmotors range from single to triple reduction, 1- to 150-hp ac. Speed reducers are from 1- to 75-hp ac with output speeds as low as 1.2 rpm. Howell Electric Motors Company

SILICONE NEWS from Dow Corning

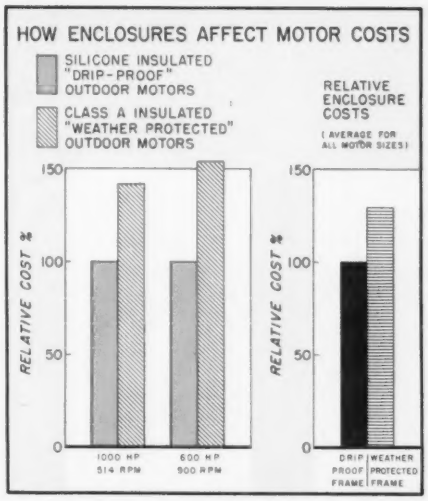
What Price Difference?

There's No Price Premium . . . Just Savings . . . When You Specify Silicone Insulation

For Outdoor Locations: You can save 30% and more on initial cost of form-wound motors by specifying silicone insulation systems made with Silastic, the Dow Corning silicone rubber. Here's why: 1) Silicone insulated motors are now available at no price premium; 2) The insulation system itself is self-protecting, shrugs off weather, humidity, corrosion, dust, even flooding. There's no need for elaborate enclosures that push motor prices up and up. The chart (right) shows how much you save by specifying silicone insulated open motors.

For Indoor Locations: Where ambient temperatures are high, where corrosive fumes or industrial contaminants are present; where relative humidity is pushing 100%; where motors are hosed down — in all these applications and others, too, expensive motor enclosures, and often expensive ducting as well, can be eliminated by specifying silicone insulation.

For Any Location: Silicone insulation systems increase motor service factor by as much as 15 to 30% because of their greater thermal stability. This increased service factor means there's no need to overmotor for occasional overloads . . . and suffer the power factor penalty of part loaded induction motors.



This chart shows one of the ways you save by specifying motors insulated with Silastic.

New brochure on Silicone Insulation. Write for your free copy. Address Dept. 7014.

first in silicones

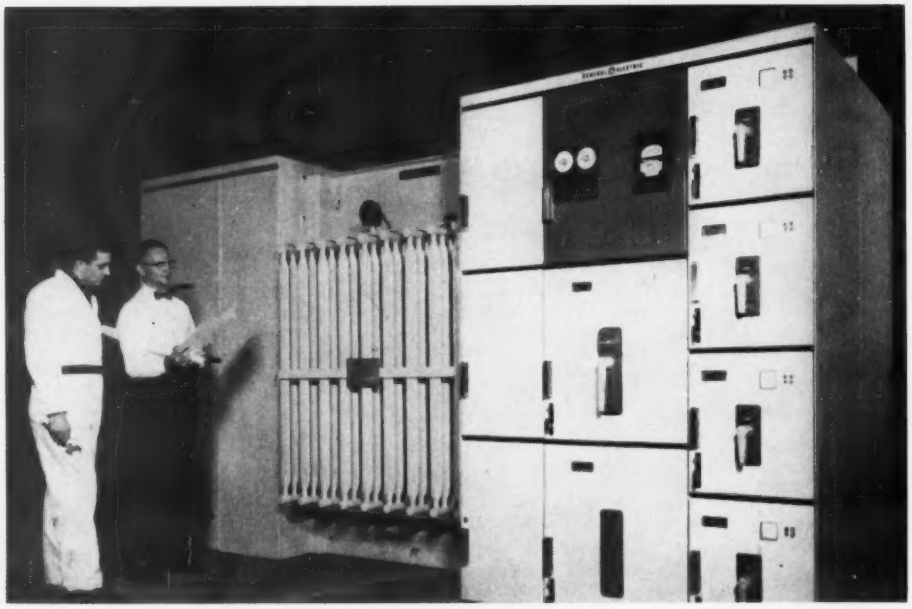
Dow Corning CORPORATION
MIDLAND, MICHIGAN

ATLANTA BOSTON CHICAGO CLEVELAND DALLAS LOS ANGELES NEW YORK WASHINGTON, D. C.

For more facts circle 261 on Reader Service card, p 103

For more data on these developments, circle key numbers on Reader Service card, p 103

Plant equipment news... Your

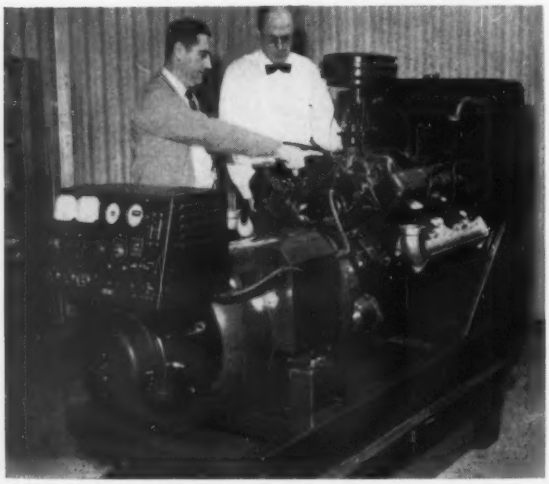


Drawout switchgear gives premium design and safety to subs

1 • Custom-tailored l-v switchgear, part of a load-center unit substation, has greater reliability, convenience and operator safety than conventional equipment, according to maker. For utility generating stations using 600-v ac and below, Powermaster protects against short-circuit spreading which could lead to costly downtime.

All controls, including fuses in pullout dead-front fuse holders, are accessible from the front. Control power transformer, potential transformer and associated fuses mount in a separate auxiliary compartment in front and are easily removed. Racking mechanism lets you rack breakers to "connected," "test" or "disconnect" with compartment door closed. For extra safety, positive interlocks prevent inserting or withdrawing closed breaker.

Switchgear comes with convenient wire connections and cable supports for easy cable installation. Breaker-handling device is an integral component helping you remove breakers. Equipment is attractive, can be placed anywhere. Mount separately or as outgoing section of load-center unit sub.—General Electric Co



Electric plant is rated 85-kw standby, 75-kw continuous duty

2 • Heavy-duty electric plant is available in all standard voltages for both gasoline and gas-cooled operation. Radiator or city-water-cooled models have remote or push-button starting.

Unit has a 12-lead generator with direct-connected exciter. 24-v cranking wingings give higher cranking speed, more positive starting, according to manufacturer. The engine is 8-cylinder V type, 168 hp at 1800 rpm.

Standard equipment includes automatic voltage regulator, antidieseling device for gasoline models, electric-solenoid gas-shutoff valve for gas models, low oil-pressure and water-temperature cutouts. Combination controller and instrument panel mounts on plant. Heavy-duty skid base, vibration mounts give accurate alignment, quiet operation, maker says.—Kohler Co

information center for new products and materials

Fibrous glass shrouds unit, keeps it quiet

3 • Molded acoustical insulation replaces pasted insulation, reduces overall insulation costs, maker says. Molded in specially designed shapes, insulation is being used to deaden noises from air-conditioning compressors but is available for a wide variety of insulating tasks.

Fibrous-glass unit is made in two halves for simple assembly. It's sprayed with vinyl surface coating for easier handling. Units have a density of 6 lb per cu ft for good insulation, minimum weight and space. —Fibrous Glass Products, Inc

Cartridge check valve is easy to install

4 • Nonleaking valve is for any pneumatic or hydraulic system. Designed to be placed in single bored hole, it avoids bulky complicated piping arrangements. According to maker, valve lets you save over 75% of design and installation costs.

Unit avoids threaded connections and expensive machinery while retaining all advantages of check valve. C-200 cartridge check valve comes in steel or aluminum in sizes from ⅛ to ¾ in. It operates at pressures up to 5000 psi, according to maker. —Circle Seal Products, Inc

Metal hose has high pressure rating, flexibility

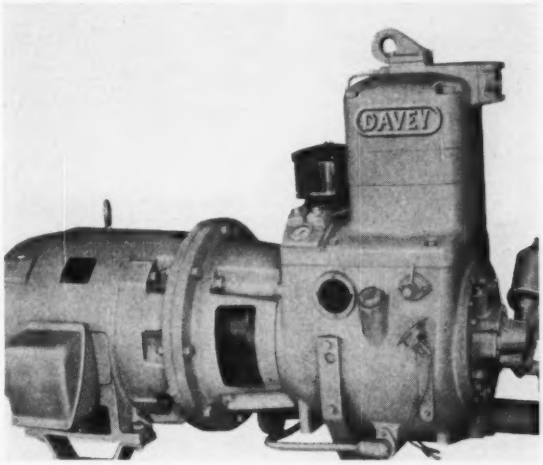
5 • Metal hose comes in sizes from ¼ to 1¼ in. helically convoluted, braided or unbraided. According to maker, hose has single longitudinal weld, smooth helical convolutions so it can be easily cleaned to high levels of purity for cryogenic and sensitive applications.

Suggested application: for utility piping. Working pressures in the ¼-in. size run as high as 4500 psi with static band radius of 1.03 in. Hose was specifically designed for maintenance and original equipment.—Flexonics Corporation

Oil-cooled compressor uses less oil, reduces oil in air

6 • Stationary rotary compressors in 2- to 125-hp sizes have new type oil separator. 40-hp unit, right, shows separator at top. According to manufacturer, separator reduces amount of oil the compressor consumes and oil content in air the compressor produces.

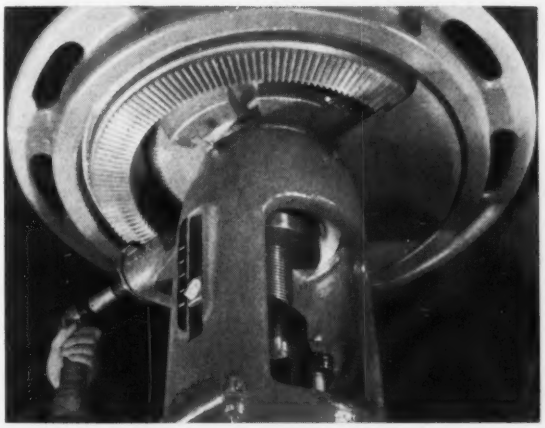
Separator has an inorganic fiber-glass element. This accumulates fine particles of oil that drain back to intake section of compressor through pressure-reducing oil-return valve.—Davey Compressor Company



Air-powered valve operators extend range of sizes

7 • Impactogear valve operators formerly available only for large-size valves can now be used on 8-in. and larger 900-lb valves, 8-in. and larger 1500-lb valves, 6-in. and larger 2500-lb valves. According to maker, operator cuts manpower five to one: it lets one man operate high-pressure valves quickly and easily.

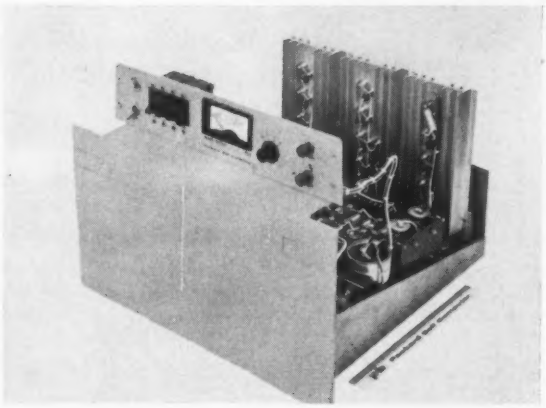
Unit is a ring gear and pinion assembly fastened to handwheel and valve yoke. Portable air motor and existing plant 90-psi compressed air turn pinion gear and handwheel through standard wrench. One man can run the stem of a valve up and down instead of a crew of 2 to 5 men. Hammer-blow action of handwheel gives tight shutoff.—Edward Valves, Inc



For more data on these developments, circle key numbers on Reader Service card, p 103

More **equipment news**

For more data on these developments, circle key numbers on Reader Service card, p 103

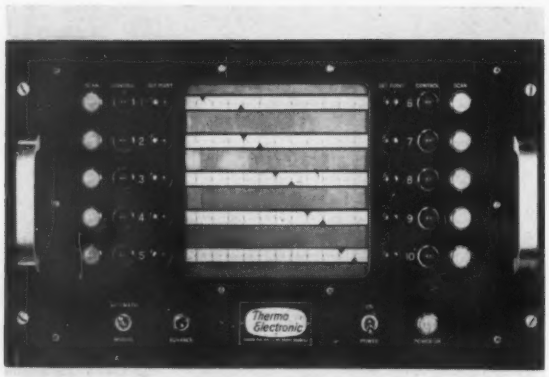


Computer operates from battery for emergencies, erratic power

8 • Electronic computer PB 250 normally operates from a standard 115-v power line. But it needs so little power that you can rig it up with a battery supply, use for emergencies or where power is erratic or unreliable.

During operation, trickle charging continuously regenerates battery. If 115-v input is interrupted computer can continue for one hr or more. Battery supply uses sealed cells operating five years without service, maker says.

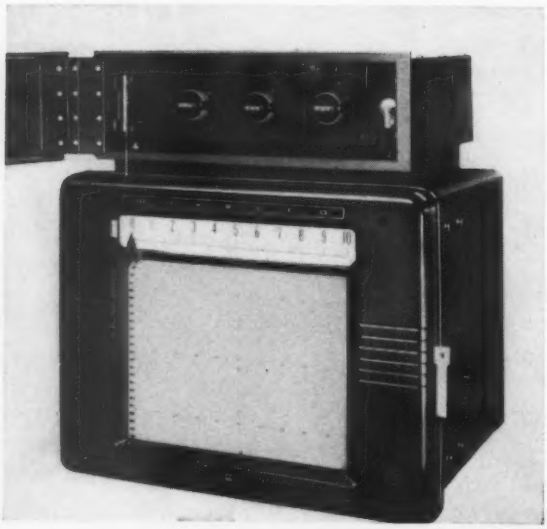
Computer executes thousands of mathematical operations every second; you can charge battery supply even from poorly regulated generators as efficiently as from a power line.—Packard Bell Computer



Temperature controller gives automatic 2-position control for ten processes

9 • Unit saves space, cuts installation and maintenance time. Use as single-point controller, 5-point 3-position controller and manual-balance indicator. You can monitor other processes with points not used for controlling multiple-temperature process.

Controller combines sensitive null-balance potentiometer measuring circuit with electronic control system. You can use it for any installation requiring on-off control. Accuracy is 0.5% of range. All controls are located on front panel for convenience. Knobs give quick control-point setting.—Thermo Electric Company, Inc



Recorder features span and zero settings on calibrated dials

10 • Adjustable span and zero recorder ends external calibration, maker says. The two settings (zero and span) let you measure an unknown simply by changing dial settings—there's no time-consuming calibration. 1-mv span and 1-sec cross-chart speed are standard.

Span accuracy is ½ of 1% of the set value. Zero settings are accurate to ½ of 1%; you can read them at a glance, manufacturer says. Adjustments are simple to make and there are only three: calibrated span vernier, calibrated zero vernier and arbitrary amplifier-gain control. Calibrated zero vernier gives any value from 0 to 50 mv of suppression for exact settings. Span is continuously adjustable from 0 to 20 mv. A feature: when one dial is set you can set second dial without changing already-set dial. Control switches are adjustable over 100% of range. —Barber-Colman Company

For more data on these developments, circle key numbers on Reader Service card, p 103

Refractories that last longer

- Extensive Line of Plastic and Castable Refractories to *Exactly* Meet Any Service Condition
- Refractory Engineering to Precisely Match the Proper Refractory to the Job—No Matter How Large or Small
- Installation by Highly-Skilled Company Representatives Makes Certain Engineering Recommendations are Followed

Unified Responsibility Assures You the Finest Job Possible

Send for "The Plibrico Story" for Details of this Integrated Service

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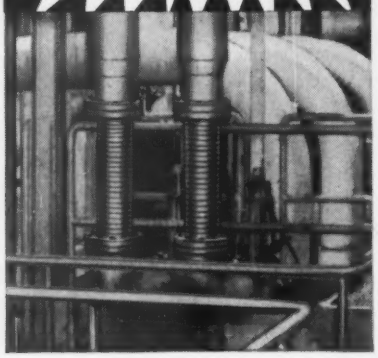
PENFLEX
CUSHIONS THE BLOW
IN BLOW-OFFS



FLEXIBLE METALLIC TUBING
ABSORBS STEAM RELEASE SHOCK

Shock, expansion, temperature, pressure all suddenly combine to liberate steam at 900°F. and 850 psi. The expansion joints get the full impact as the blow-off valves release the steam. No place for a weak-kneed joint. That's why the operator in this large power plant installed Penflex stainless steel interlocked (8" I.D.) expansion joints.

Penflex Expansion Joints are dependable because they have been tested and proved to be strong, tough and flexible enough to stand the shock, pressure and thermal expansion. This is just one of the hundreds of "job-proved" applications of Penflex expansion joints. Proper selection and application of flexible tubing is assured with Penflex "Flexineering" . . . a service that is yours to assure you of more efficiency on each installation. Write today for "Flexineering" data book and catalog to **Pennsylvania Flexible Metallic Tubing Co., Paoli, Pa.**

Penflex

TIGHT AS A PIPE . . . BUT FLEXIBLE

circle 263 on Reader Service card, p 103

Magnetically attaching bimetal dial thermometer

31 • Three styles are available: for measuring temperature only; with maximum reset hand; electric contactor permitting on-off temperature control with electric resistance or induction heating. Range is −60 to +700 F with accuracies better than 2%, maker says. Applications include measuring and controlling preheating for welding; steel tank, vessel and pipe process control and checks; determining heat loss across furnace, oven and steel walls.—Industrial Service Co

Immersion heaters have perforated-fintube design

68 • U-shaped units are for heating or keeping pumping temperatures of asphalt and heavy coils for loading, blending or storage purposes. You can also use on fluids where no steam supply is available. Fired with either gas or oil, 8-in. firetube has 750,000-Btu-per-hr capacity, 10-in. has 1,250,000.

New fins give higher heat-transfer rates, accelerate thermal currents within the tank, maker says. Lowered specific gravity lets material next to perforated fintube circulate freely, heat fast, rise rapidly, preventing material stratification. This keeps surface clean and free from sediment. —The Brown Fintube Company

Just circle key numbers on the Reader Service card, page 103, to get complete product story

Plastic sealant repairs end-bell bearings

26 • Sealant acts as liquid shim, fills slight clearance between bearing OD and worn end-bell housing in electric motors. Sealant hardens to perfect fit, maker claims. You can do the job in less than 15 min.—American Sealants Co

continued

危機

CONSECO

THIS (they tell us) means "crisis," in Chinese. One character spells "danger". The other, "opportunity".

So, when you come to the "crisis" of finally selecting competing equipment, don't court "danger" of future trouble . . . grasp your "opportunity" to get the BEST from CONSECO . . . even when it doesn't cost MOST! And remember, CONSECO will handle your WHOLE job, from blueprint to installation and maintenance. Allee samee complete service, no?

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DESIGNS • BUILDS • ENGINEERS
DELIVERS • INSTALLS • MAINTAINS

All Condensing, Feedwater Heating, Evaporating, Air Removal and Condensate Cooling Equipment for any Thermal Power Generating Plant.

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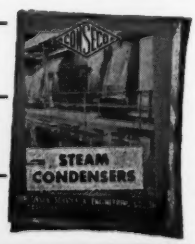
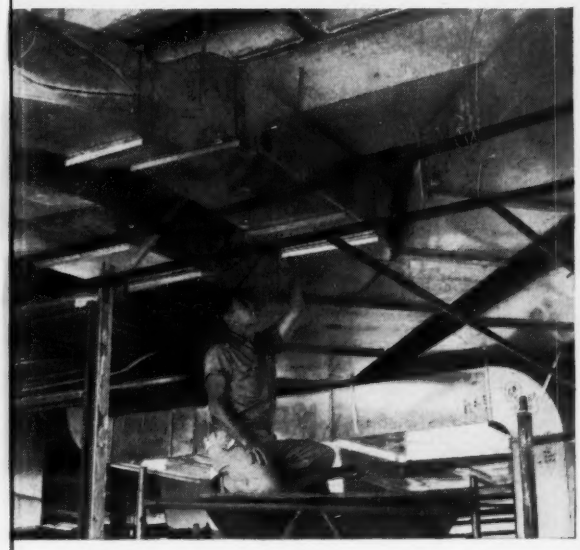


circle 264 on Reader Service card, p 103
circle 265 on Reader Service card, p 103 ➤

Right, PPG insulation is easily cut to size on the job. Left, Foreman Charles W. Booth, of Acheson Sheet Metal Company, supervises installation of ductwork. PPG Neoprene-coated Duct Liner meets all requirements of NBFU Bulletins No. 90-A and 90-B for ducts, and bears the label of Underwriters' Laboratories, Inc.



The inside story on a hush-up job in Tampa

(with PPG Fiber Glass Insulation, of course!)

It will be quiet, as well as comfortable around the new State Agency Building at Tampa, Florida, because PPG Fiber Glass Insulation has been installed in the ductwork of the heating and air conditioning system.

Job foreman Charles W. Booth of Acheson Sheet Metal Company, Jacksonville, installers of the ductwork, reports that the long life-expectancy of PPG Neoprene-coated Fiber Glass is of great importance in the choice of this insulation, because of the difficulty of replacement in a duct system.

It's what's inside that counts!

Mr. Booth says that PPG Insulation has extraordinary sound-deadening qualities which eliminate fan noise, has excellent thermal-barrier characteristics, and low resistance to air flow. In addition to ease of handling and installation, it will not be affected by humidity, won't swell, rot or decay . . . very important in Tampa-types of climates!

Get best results with PPG

Available in a range of sizes, densities, and facings to meet any insulation specification. For more information, contact your nearest Fiber Glass Sales Office, or write *Pittsburgh Plate Glass Company, Fiber Glass Division, One Gateway Center, Pittsburgh 22, Penna.*

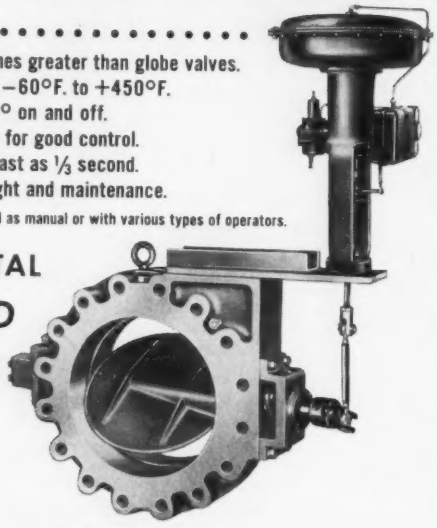
Sales Offices: Atlanta, Boston, Buffalo, Charlotte, Chicago, Cincinnati, Cleveland, Dallas, Denver, Detroit, Fort Wayne, Houston, Jacksonville, Kansas City, Los Angeles, Louisville, Milwaukee, Minneapolis, New Orleans, New York, Philadelphia, Pittsburgh, San Francisco, St. Louis, Seattle and Washington.

FIBER PPG GLASS PITTSBURGH PLATE GLASS COMPANY

NOW! A BUTTERFLY VALVE THAT'S BUBBLE-TIGHT AT 500 PSI!

- Capacity approximately 1½ times greater than globe valves.
- Handles temperatures from −60°F. to +450°F.
- For 60° throttling or 90° on and off.
- Equal percentage flow for good control.
- Closing speeds as fast as ⅓ second.
- Low in cost, weight and maintenance.

Available in special materials or construction and as manual or with various types of operators.



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RUBBER-SEATED
VALVES

For complete details about Fisher-Continental Butterfly Valves send for free literature.

FISHER GOVERNOR COMPANY
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Direct Inquiries to: CONTINENTAL EQUIPMENT CO. DIVISION, Coraopolis, Penna.

FISHER Controls

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EASY-TO-USE STEEL GRATING CATALOG

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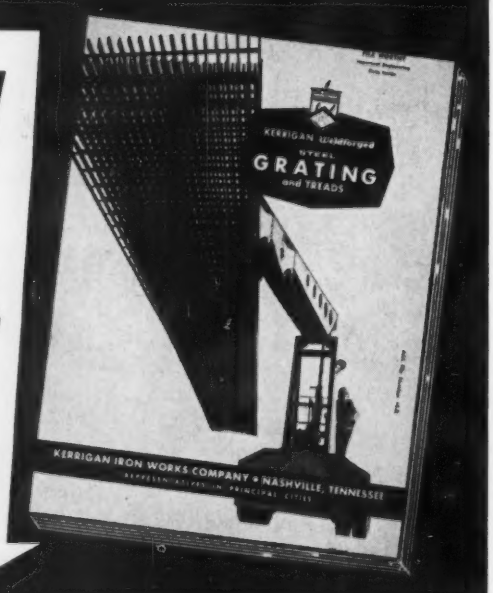


Dept. P-2 **KERRIGAN IRON WORKS CO.** Nashville, Tenn.

NAME _____

FIRM NAME _____

CITY _____ STATE _____

For more facts circle 267 on Reader Service card, p 103

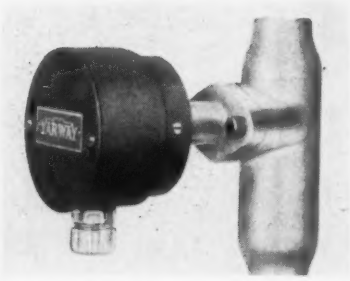
Equipment news

Begins on page 112

General-purpose hose clamp

25 • Clamp has no perforations through the band to cause rubber extrusion or scuffing. Steel screw engages on coined threads. Clamp is easily removable if required. Maker says it will not snap open or jog loose. You can adjust diameter for many applications.—Aeroquip Corp, Marman Div

Just circle key numbers on the Reader Service card, page 103, to get complete product story



Leakproof sensing device

35 • Sensing device for detecting control of process variables uses wire-in-tube element for transmitting motion through pressure-tight wall without bellows, seals or stuffing boxes. Element is flexible curved tube with spring wire inside. Operation: change in level deflects tube's end; flow or other variable rotates wire, indicating change or even operating a switch.—Yarnall-Waring Co

Nonwoven graphite and carbon felts

66 • Use these h-t flexible materials to insulate, filter gas or for gaskets. Air oxidation will be no problem up to 700 F. You can use felts at temperatures to 5000 F. Strength at 3000 F is doubled at room tem-

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Atlantic City Electric Co.
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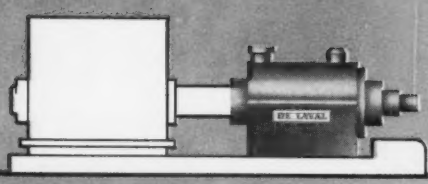
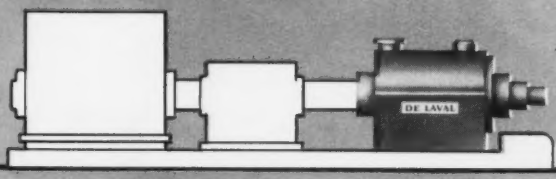
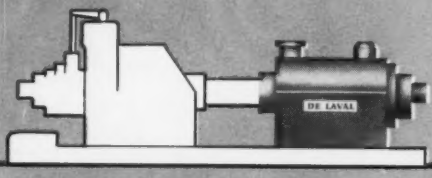


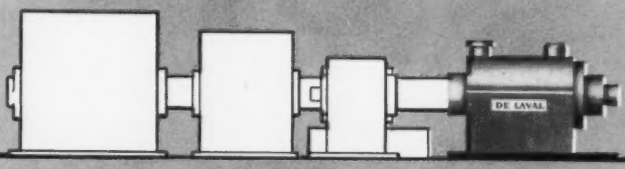
Motor-Hydraulic Coupling Drive
Commonwealth Edison Co.
5000 HP 325 MW



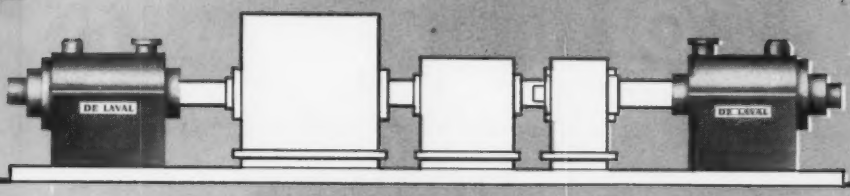
Turbine Drive
United States Steel Corporation
1400 HP 44 MW



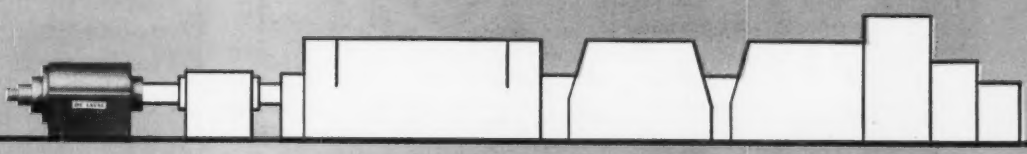
Motor-Magnetic Coupling—Gear Drive
South Carolina Electric & Gas Co.
2500 HP 5100 RPM
125 MW



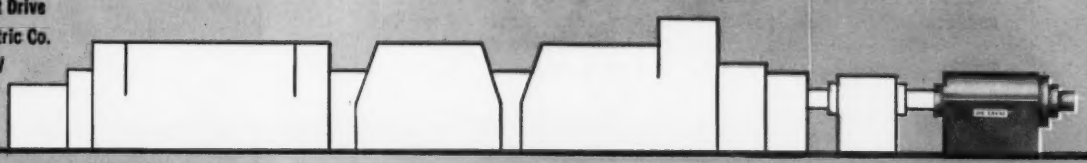
Supercritical Cycle
American Electric Power System
4000 HP 6500 RPM 5500 PSIG 120 MW



Main Generator-Shaft Drive
Commonwealth Edison Co.
4900 HP 325 MW
(FUTURE UNIT)



Main Turbine-Shaft Drive
Pacific Gas & Electric Co.
5250 HP 330 MW



DE LAVAL STEAM TURBINE COMPANY
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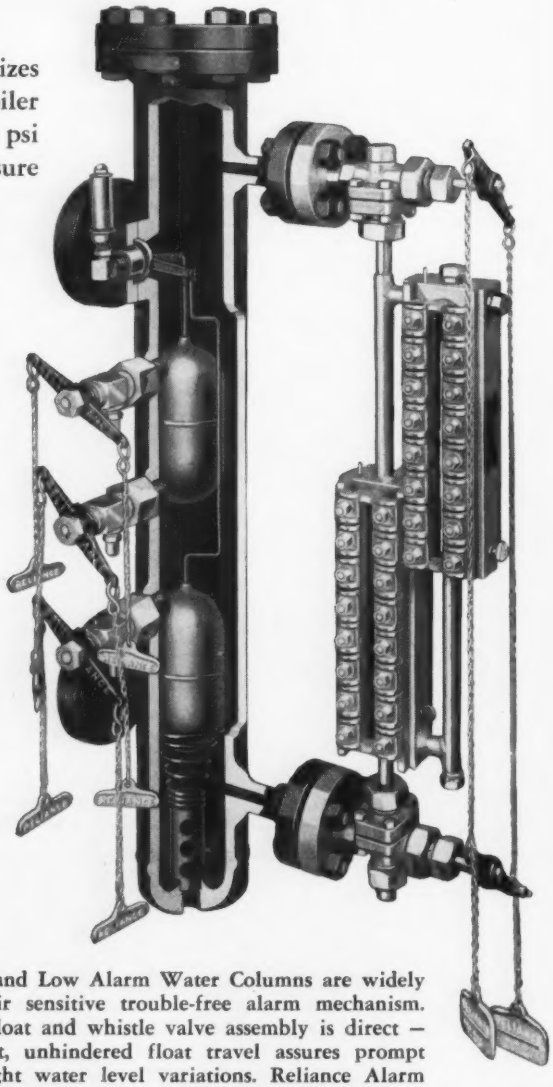

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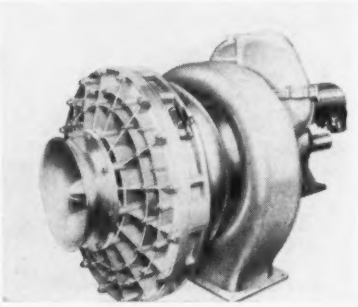
Reliance® BOILER SAFETY DEVICES

120 **For more facts circle 269 on Reader Service card, p 103**

Equipment news

Begins on page 112

perature; electrical resistance decreases at 2500 F to about half room-temperature value. Eight grades are available in sheets 32- to 36-in. wide, 36- to 87-in. long.—National Carbon Company



Industrial gas turbine develops 400 hp

65 • Unit has centrifugal compressor, annular combustor, 2-stage-turbine section and integral speed—reducing gear case. The 400-hp rating can be provided at output shaft speeds of 2500 or 3600 rpm. Free-shaft feature gives high torque at zero rpm, states manufacturer. Waukesha Motor Company

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Plasma torch produces heat without fuel

64 • Torch uses an RF field to generate heats almost as strong as the sun without consuming any fuel or electrodes whatsoever, according to maker. It operates by using energy of a high-frequency electromagnetic field to dissociate and ionize gas molecules into their component atoms. Gas in this form is called a plasma. Torch then lets atoms recombine into their original state. Energy absorbed is liberated in the

...the most unusual curtain wall

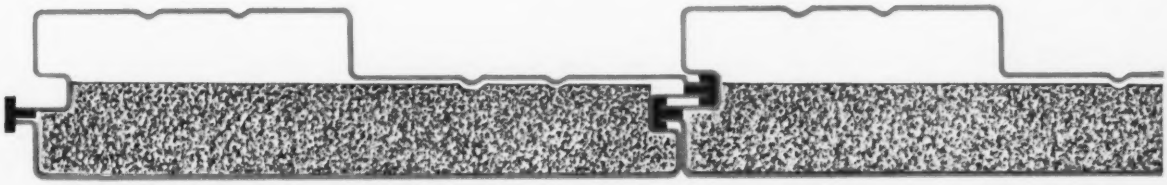
MONOPANL

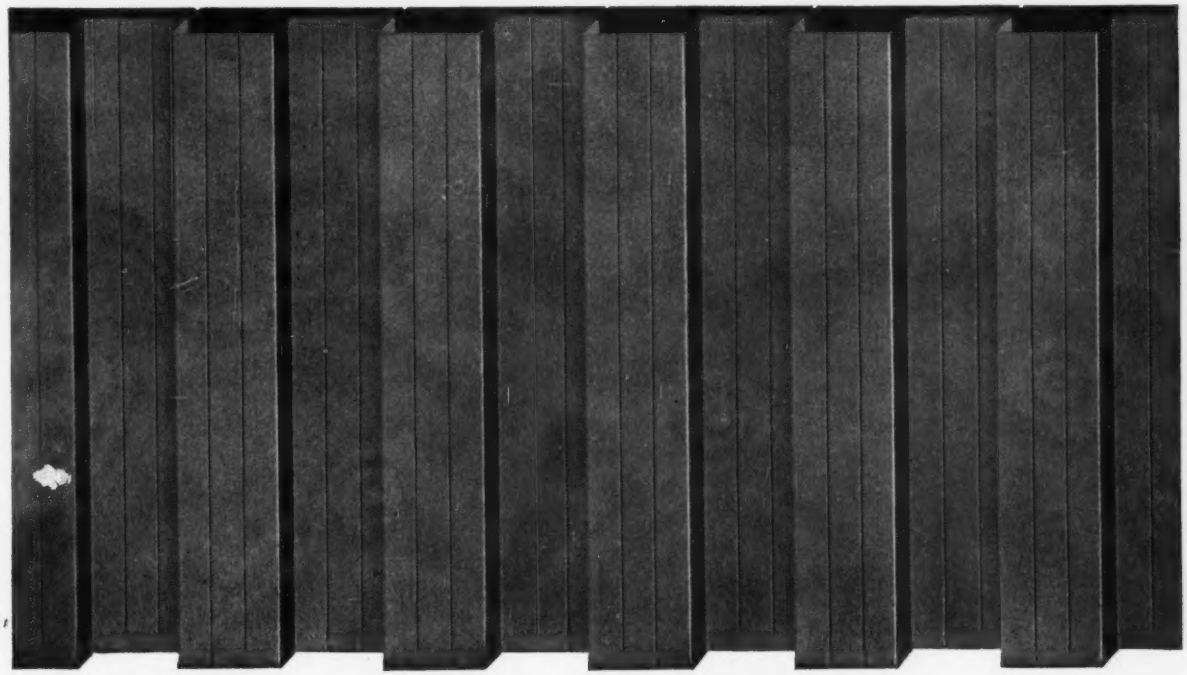
A factory-assembled wall panel in one foot modules . . . one that is self-sealing for life by mere installation. You never caulk it. And there are no visible outside joints or fasteners to mar the surface. This is Butler Monopanl, the most unusual curtain wall. Tongue-and-groove joints with double vinyl gaskets provide the seal. The cross section sketch tells the story.

Spanning ability is exceptional, as you can see from the configuration. Glass fiber insulation will not settle.

Beautiful Monopanl is furnished in a range of gauges. Exterior and interior faces can be specified in aluminum or galvanized steel. Choose from a selection of factory-applied colors. Integral fenestration is available.

For further information refer to Sweet's 1960 Architectural File. For complete technical details and actual samples of Monopanl, contact your Butler Builder He's listed in the Yellow Pages under "Buildings" or "Steel Buildings." Or write direct for a descriptive brochure and data sheets.





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"See Sweet's Industrial Construction File—Section 8-B"

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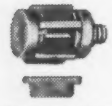
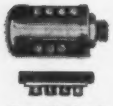


Expanding scraper and replaceable element.



Expanding brush and replaceable element.

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Rotojet Junior Tube Cleaners are unusually powerful for their size and weight. They are fed easily through the tubes with the operating hose, and can be shifted quickly from tube to tube. Their convenient size, speed, and ease of operation offer a marked contrast with external cleaners costing many times more.

An air valve directly behind the Rotojet motor permits one-man operation. Very little headroom is required, and either vertical or horizontal tubes can be cleaned.

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Equipment news

Begins on page 112

form of heat. Coil or coaxial cable creates electromagnetic field. — Amperex Electronic Corp

Miniature inertia switch

69 • Model 6UO-200 is preset to respond to acceleration forces up to 250 G within a tolerance of ±15% of setting. Switch has one moving part—steel ball held against a solid base by uniform magnetic field—which moves to close an open electrical contact. Operating range is –65 to +200 F. You can use for limiting applications.—Inertia Switch, Inc

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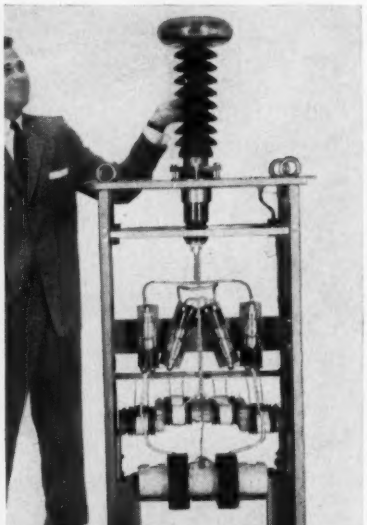
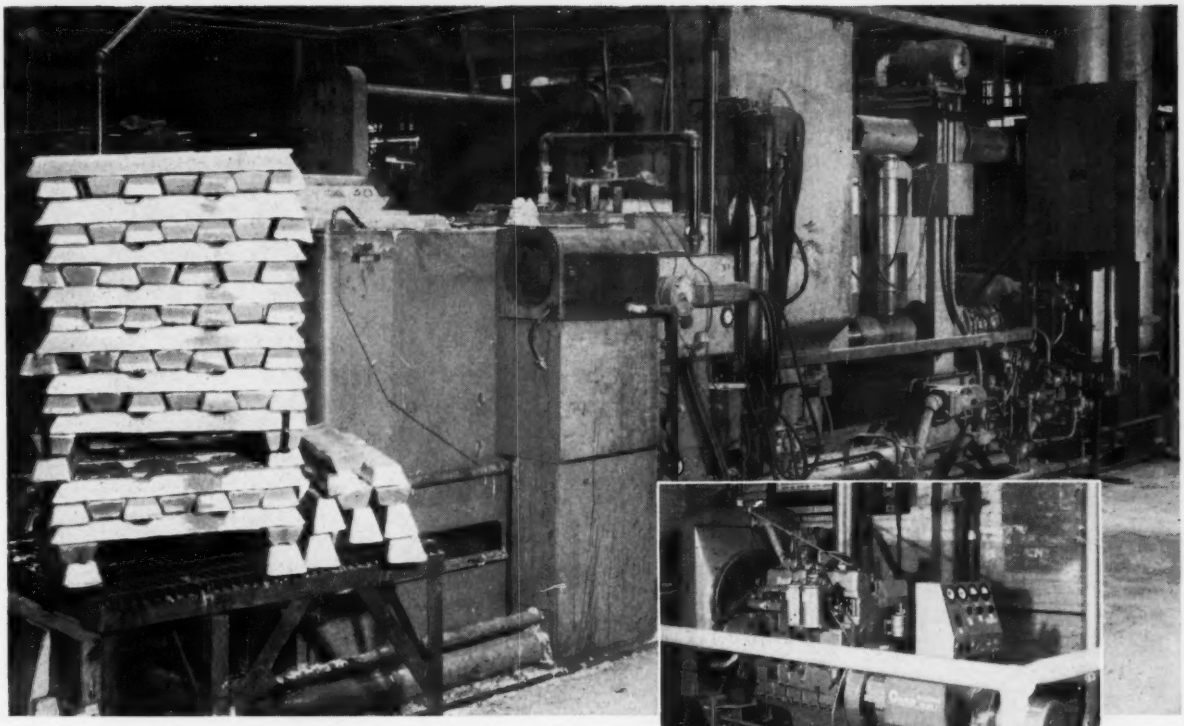


H-v power unit

67 • Transformer section of unit, above, has full-wave rectified output of 100 kvp, 5 ma, is convertible for negative or positive ground. Use for electrostatic spraying, dust precipitation and coating- and insulation-breakdown testing. — Century Coil Corporation



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So when you're tempted by an electric plant "bargain," make sure its nameplate rating is not "inflated." Be sure you're getting full measure for your money. Remember, *the electric plant that shortchanges you in power output is no bargain at any price!* Only Onan is Performance Certified to deliver everything the nameplate promises.

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We certify that when properly installed and operated this Onan electric plant will deliver the full power and the voltage and frequency regulation promised by its nameplate and published specifications. This plant has undergone several hours of running-in and testing under realistic load conditions, in accordance with procedures certified by an independent testing laboratory.
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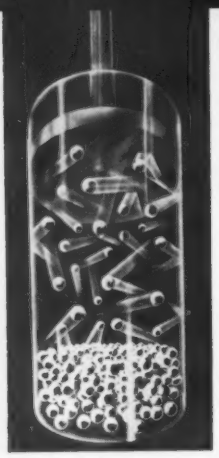

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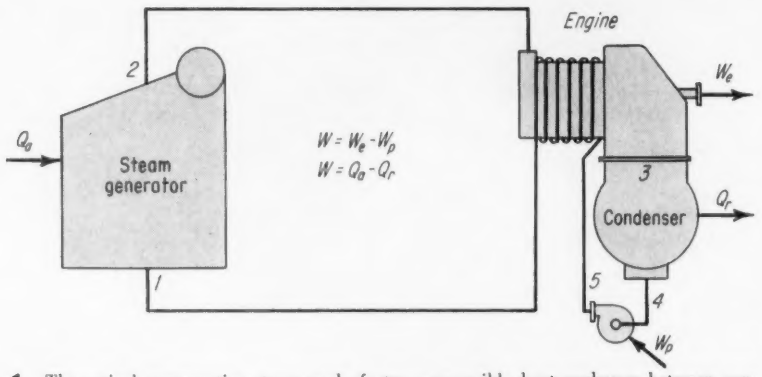


1 Theoretical regenerative steam cycle features reversible heat exchange between condensate returning to steam generator and steam expanding reversibly in the engine

Ingenuity of early plant designers uncovered the possibilities of approaching Carnot-cycle performance with steam as the working fluid. This month we'll study . . .

Regenerative steam cycles for top efficiency

By B G A SKROTZKI, Associate Editor

We've already learned of the Rankine cycle's limitations in approaching performance of the ideal Carnot cycle. A steady-flow steam cycle can duplicate Carnot performance, within limits, by adapting some of the tricks of regenerative reciprocating-engine cycles—see Part 13, POWER, Nov 1957, pp 90-93.

Fig. 1 shows the Rankine-cycle layout modified for regenerative feedwater heating. Modification features an ideal reversible heat-transfer surface between steam expanding in the engine and feedwater returning from condenser to steam generator. Ideally, this means water entering the steam generator has same temperature as steam entering the turbine.

Cycle processes. Fig. 2 shows the effect of the heating process on feedwater and steam expansion in the engine. Chart assumes steam leaving the generator is dry and saturated. Heat given up by the steam Q_s equals heat absorbed by the water Q_w. So entropy gain of the water equals entropy loss of the steam. This means that the area under water heat gain *5-1* or Q_w equals area under steam heat loss *2-3* or Q_s and has exactly the same shape. Process lines *5-1* and *3-2* are parallel.

So a sizable amount of energy continuously stays within and circulates in the cycle. This makes the steam exhausting to the condenser at state *3* very wet—about 75% moisture.

Fig. 3 shows the complete cycle of processes. Water enters the generator at state *1* as a saturated liquid. Q_a simply adds the heat of vaporization without need for subcooled-liquid heating, and it's all added at constant temperature, a requirement for achieving Carnot thermal efficiency. The steam expands polytropically to a very wet state as we noted. Then heat is rejected as Q_r in the condenser; because of the wet state, Q_r is relatively small.

Taking into account all the areas under the processes, heat added to water and steam = $Q_w + Q_a$. Heat given up by steam = $Q_s + Q_r$. The difference, by the First Law, must equal the shaft work W; then:

$$W = Q_a + Q_w - (Q_s + Q_r) \quad (1)$$

But $Q_w = Q_s$, so we get:

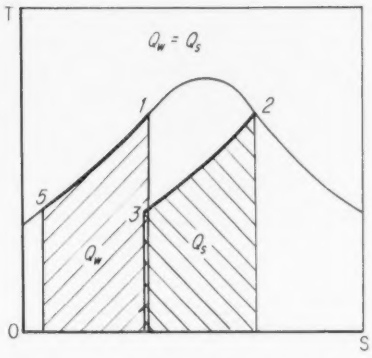
$$W = Q_a - Q_r \quad (2)$$

Net work area W is the slanted area enclosed by heavy process lines *1-2-3-4-5* in Fig. 3.

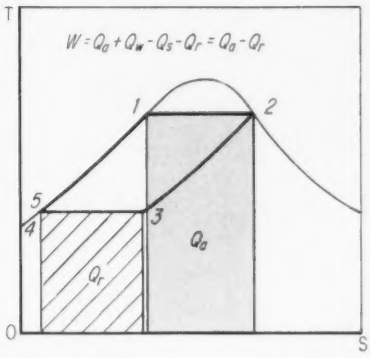
Thermal efficiency of the cycle:

$$e = \frac{Q_a - Q_r}{Q_a}$$

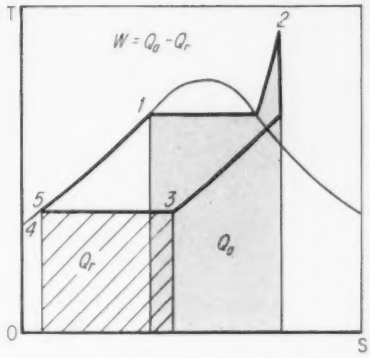
$$= \frac{T_1(S_2 - S_1) - T_3(S_3 - S_4)}{T_1(S_2 - S_1)} \quad (3)$$



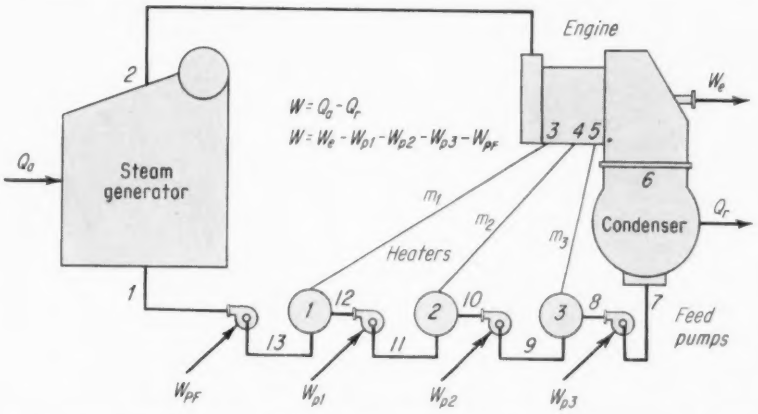
2 Heat Q_w absorbed by water equals heat Q_s given up by expanding engine steam



3 Saturated regenerative cycle works at Carnot efficiency at ideal conditions



4 Superheated regenerative cycle gains from internal-cycle heating of water



5 Practical regenerative cycle bleeds steam from engine to warm feedwater in mixing heaters. Condenser steam flow is diminished by amount of steam bled for heating

But $(S_2 - S_1) = (S_3 - S_4)$, so:

$$e = \frac{T_1 - T_3}{T_1} \qquad (4)$$

Net effect of the regenerative cycle raises average temperature at which Q_a enters the cycle. The special case of using saturated steam at the engine inlet is met by completely eliminating external heating of the water to the saturated state.

Practical cycles would be seriously limited if we did not take advantage of superheating steam. Fig. 1 would be arranged so the steam transfers heat to the water only after it has expanded to the saturation temperature of the water, Fig. 4. Here we recede from the conditions for Carnot efficiency because *all* the heat is not added at highest temperature, but we gain by having an overall higher average temperature than that for the saturated cycle. Partial regeneration offers a big gain in thermal efficiency.

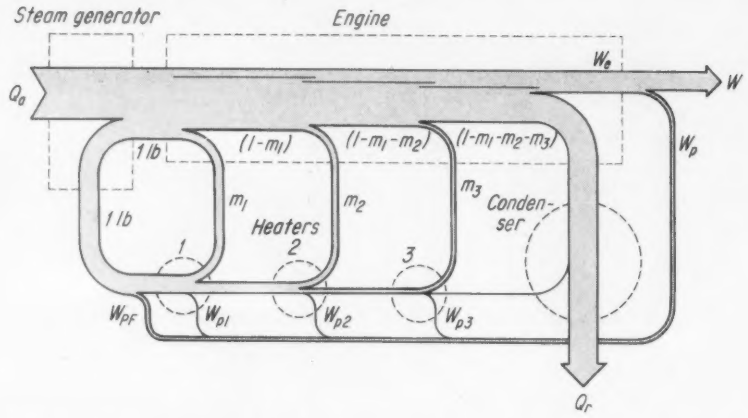
Bleeding cycle. The wet exhaust steam of the ideal regenerative cycle proves a major practical defect. The engine is usually a turbine and as expansion and cooling make the steam wetter the moisture builds up as minute fog droplets.

The speed with which steam flows through the nozzles and buckets of a turbine gives these droplets a severe cutting ability; they can destroy the latter stages of the unit. So it becomes important to limit moisture to about 12% maximum. To achieve this another approach to regenerative feedwater heating has been worked out, bleeding steam from the engine as in Fig. 5.

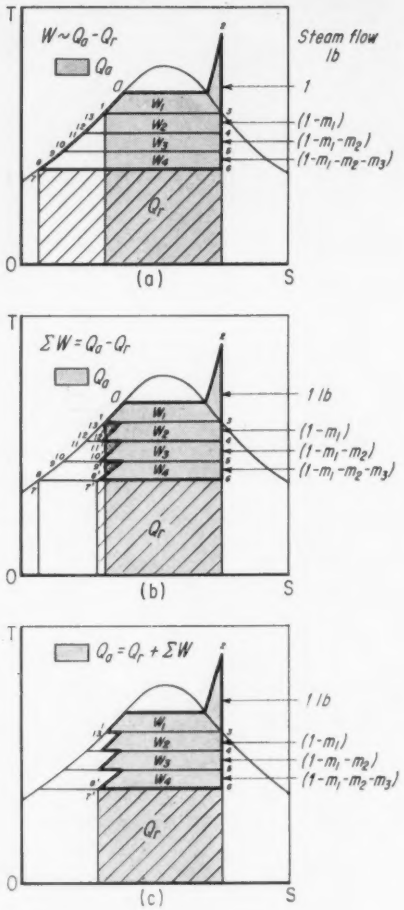
Here a part of the steam leaves the turbine at succeedingly lower pressures, flows to open mixing heaters below. Condensate from the condenser is pumped to the pressure of the lowest bleed point at state *5* and mixed with the steam in heater *3*. Steam nominally fills the heater shell and the condensate being sprayed in heats to the saturation temperature at the bleed-steam pressure by condensing some bleed steam. As the bleed steam condenses more steam flows in automatically from the engine to maintain the pressure of the bleed point in the heater.

Heated condensate then gets pumped up to the pressure of the next-higher-pressure heater *2*. Heating process draws bleed steam from point *4* at state *4* automatically. Next the feedwater is pumped to last high-pressure heater *1* fed by bleed point *3* in the engine. Here it's heated by steam bled from point *3* at state *3*. Finally the fourth or feedwater pump raises the water pressure to boiler level at point *1*.

Fig. *7a* shows the T-S chart for the bleed cycle. While the chart applies to one lb of working fluid, we have actually a varying amount of fluid flowing through different parts of the cycle. From state *2* to *3* one lb of steam expands at constant entropy through the engine. At point *3*, m_1 lb of steam bleeds off to heater *1*, see Fig. 5, and $1-m_1$ lb of steam expands in the engine to point *4* at state *4*. At point *4*, m_2 lb of steam bleeds off to heater 2 leaving $1-m_1-m_2$ lb expanding in the engine to point *5*. Here m_3 lb of steam bleeds off to heater *3* at state *3* leaving $1-m_1-m_2-m_3$ of steam to expand in the engine to



6 Energy-flow chart shows distribution of energy flow in engine sections to work, bleed steam for water heating, downstream sections. Bleed energy recirculates



7 (*a*) T-S chart for bleeding regenerative cycle shows state of fluid at each point in cycle for one lb of fluid. But weight of working fluid varies during both steam expansion and water heating. (*b*) T-S chart proportioned to actual fluid flow shows net work W as difference of Q_a and Q_r without net work area remaining. (*c*) Alternative plot shows true Q_a as sum of Q_r and net W of engine sections

exhaust at state *6* and condense to liquid at state *7*. Condensate flow builds up as it passes through the heaters back to the boiler.

Now we're faced with interpreting the areas in Fig. *7a*. One lb of steam expanding from *2* to *3* produces work in the engine, $W_1 = H_2 - H_3$. On the chart, W_1 is measured by the area *1-a-2-3*.

One lb of steam expanding from *3* to *4* produces work $W_2 = H_3 - H_4$, measured by the net area *1-3-4-12*.

One lb of steam expanding from *4* to *5* produces work $W_3 = H_4 - H_5$ and is measured by the net area *4-5-10-11*.

Finally *one lb* of steam expanding from *5* to *6* produces work W_4, equals $H_5 - H_6$ and is measured by area *5-6-7-9*. The area Q_r measures the heat given up by *one lb* of exhaust steam. Similarly the gray area marked Q_a measures heat absorbed by one lb water in steam generator.

Q_a is true for our cycle since one lb of water does flow through the steam generator and the first section of the engine. But Q_r is much too large; only $(1 - m_1 - m_2 - m_3)$ lb of steam flows through the condenser. Similarly the net areas for W_2, W_3 and W_4 are all too large, because less than one lb of steam flows through the respective engine section. On the other hand, area for W_1 is true.

We can get a true *proportionate-area* diagram by applying the factors of actual flow as in Fig. *7b*. W_2 outlined by the heavy lines equals the similarly labeled area on Fig. *7a* multiplied by $(1-m_1)$. States marked by *11'* and *12'* are not true state points because of the ratioing factor applied to the area for W_2. True state points *11* and *12* of the liquid before and after heater pump *3* stay as shown on Fig. *7a*.

By applying $(1-m_1-m_2)$ to W_3 of *7a* we get the proportionate area of *7b*; to get W_4 we multiply by $(1-m_1-m_2-m_3)$. Multiplying by $(1-m_1-m_2-m_3)$ also gives us Q_r. Then in Fig. *7b* we have all areas in proper proportion for one lb of steam entering the engine throttle or inlet, but less in other parts of the cycle.

In Fig. *7b* the work may be measured by the difference of the gray area Q_a and the cross-hatched area Q_r. There's no simple net area left because they coincide on only two sides. But the area enclosed by the heavy lines *is* total net W for the cycle, equal to the sum of the work produced in the various sections of the engine. Then Q_a can be shown as the alternate area $Q_r + W_1 + W_2 + W_3 + W_4$ as shaded in Fig. *7c*.

The saw-tooth appearance of the liquid-heating line suggests that as the number of heaters in the cycle increases it approaches a line of constant entropy. So an infinite number of heaters will achieve maximum efficiency for the bleed regenerative cycle. Actually the best number of heaters depends on steam state at engine inlet; many medium-pressure and -temperature cycles use five to six heaters. High-pressure and -temperature cycles use as many as nine.

Energy flow, Fig. *6*, clearly shows the amount of energy recirculating in the regenerative bleeding cycle. This chart assumes that energy in the condensate is taken as datum or zero, so we just show a single line leaving the condenser on its way back to the steam generator. Energy in the feedwater and heat Q_a added to the cycle enter the steam generator to combine as energy input to the engine.

In the first engine section part of the energy converts to W_e and part leaves in the bleed steam m_1 to heater 1. The $(1-m_1)$ lb main steam with its energy flows to the second section of the engine. Here another

YARWAY news briefs

from **Yarnall-Waring Company,** *Philadelphia 18, Pa.*

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"We want 100 immediately. They meet our confined space needs perfectly."
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"Ordering 60 as first part of new standardization program."
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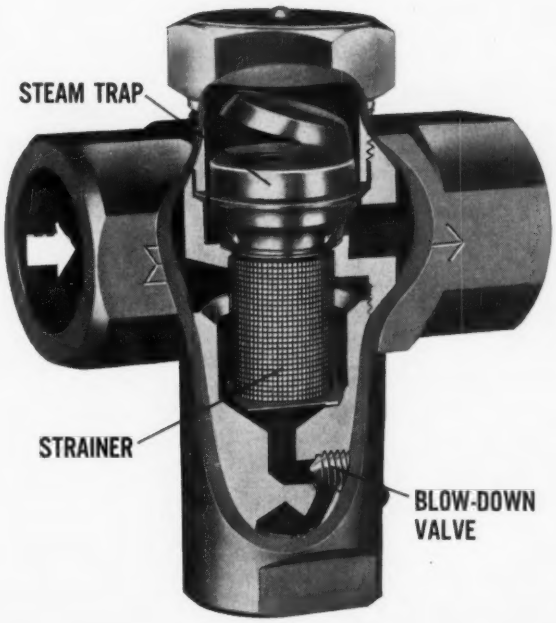
So it goes—industry's welcome to the new Yarway Series 130 combination steam trap has been a warm one. Already manufacturing quotas have been doubled to meet the demand. Yarway distributors everywhere are busy answering their customers' requests for demonstrations.

What will the new Series 130 do for you? Consider these advantages:



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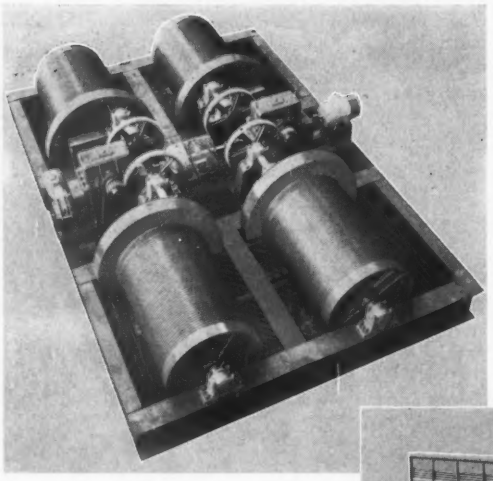
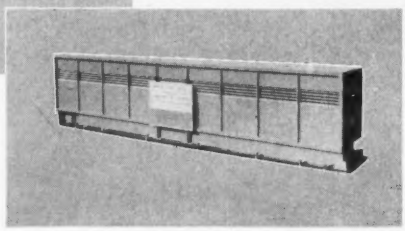


MURCO GATE HOISTS

One of the two 380-ton MURCO Gate Hoists furnished to the Power Authority of the State of New York.



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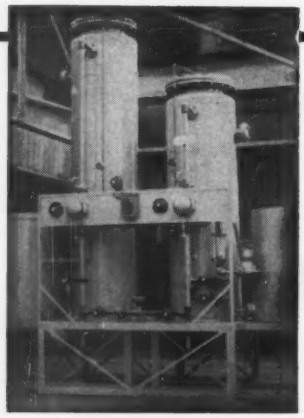

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Begins on page 124

part converts to W_e; another leaves in bleed m_2 to heater 2. In the third engine section more W_e is produced, some energy leaves in m_3 bleed to heater 3 and $(1-m_1-m_2-m_3)$ lb flows through the last section of the engine on its way to the condenser. Here the final part of W_e is produced, leaving heat Q_r to be rejected from the cycle.

Following the condensate back to the steam generator we see the bleed energy in m_3 added to heat the liquid. Pump work W_{p3} also adds energy. Energy load of the condensate is augmented in each heater by the incoming bleed steam and the pump work needed to raise condensate pressure to heater pressure. Final boost of energy comes from the last or feedwater pump, raising water pressure to the steam-generator pressure. We have shown here the recirculating nature of pump work in a steady-flow cycle. This is also true of the Rankine cycle; in earlier diagrams we simply showed W_p as withdrawn from W_e without indicating that it really recirculates through the cycle.

Next part shows how to figure a regenerative cycle and effect of heater placement.

Thermal-power station planned for Bandel, India

Zurich (*McGraw-Hill World News*) First part of a scheme for augmenting power supplies in the Durgapur and Calcutta regions is a 600-mw thermal-power station claimed as the biggest in Asia so far. U. S. development-loan fund will probably finance the unit. Station will initially have 300-mw installed capacity which will later extend to 600 mw. Expected completion: 1963.

Enlarging the existing Durgapur station from 60 to 210 mw is also in the works. U. S. development-loan fund has already made foreign-exchange financing possible by advancing some dollars—money for the rest of the project will be loaned by the West Bengal Government.

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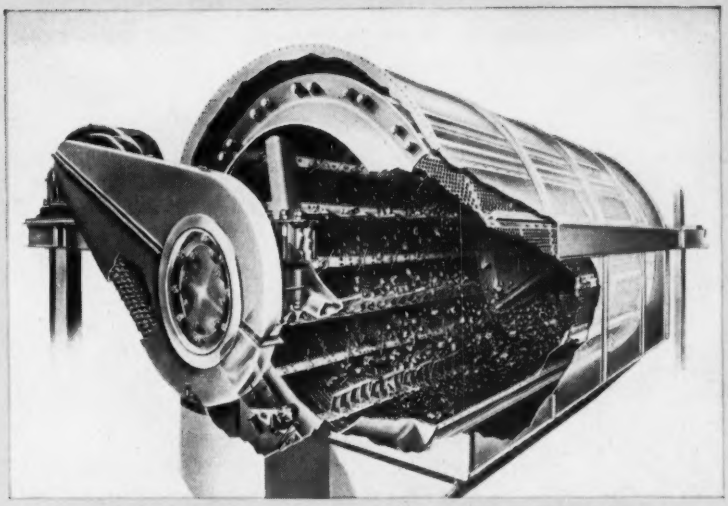

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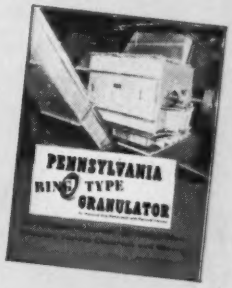

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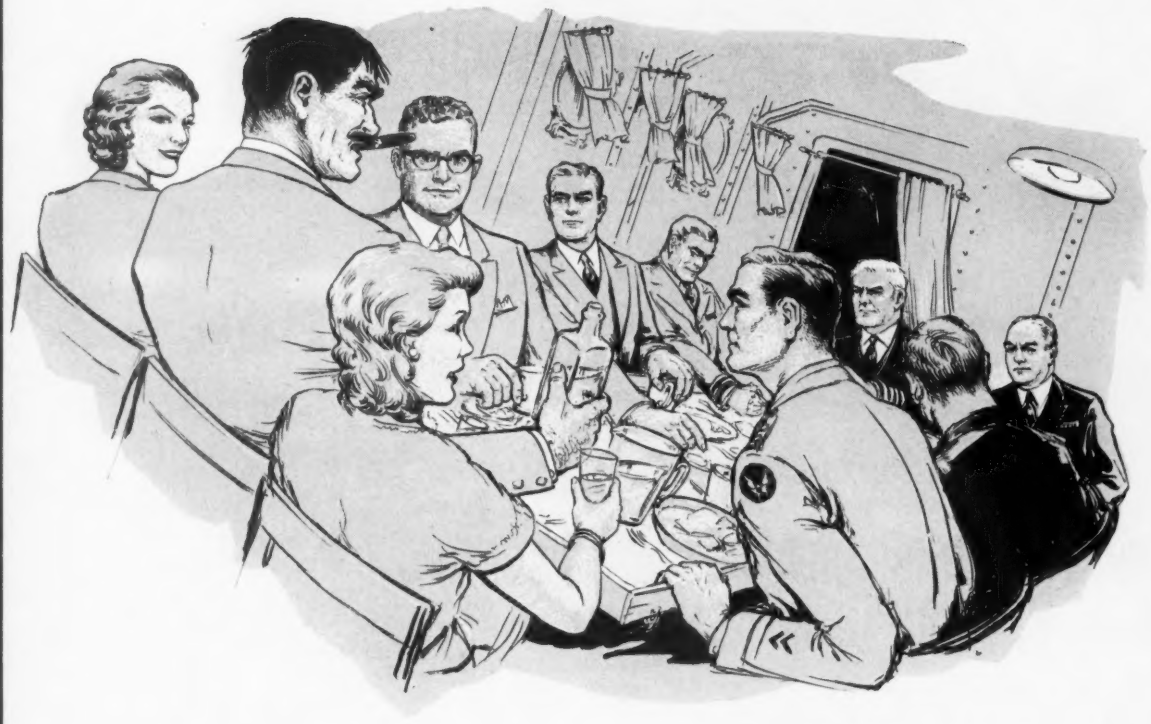

"Sure, tell Marmy what's wrong with your nasty ole putt-putt, Chief," trilled one of the young ladies

Marmy's seasick remedy

"Now hear this," blared the intercom of the *SS Cyclops* as the heavily loaded Victory Ship suddenly took a green one over her bow. "Will chief engineer Penelli come to the bridge?"

Captain Towns switched off the intercom as he braced himself against the roll of the ship. Looking at the dirty clouds brooding ominously far out over the port bow he shook his graying head and said to the second mate, "it doesn't look good, Anderson, but we should at least skirt her eye if we hold to our present course."

Just then chief engineer Penelli climbed up the starboard bridge ladder from the boat deck. He was a stout little man. Usually he wore a pleasant grin on his round face, but now he was tight-lipped and tense.

"Sorry to call you up here, Chief," said the captain, grabbing hold of a stanchion, "but the quartermaster couldn't find you and we're headed into a blistering typhoon. Sparks just got a message from the *Mongol*. She's 400 miles ahead of us and taking a terrible beating. We're lashing down everything on deck; thought you might want to secure things below."

Penelli's eyes widened. "A typhoon, Captain?," he asked, nervously lighting a cigarette.

"Yes, a typhoon—you look worried as a new plebe, Penelli. What's the matter? There's nothing wrong below, is there?" The captain's expression now matched his chief's—and both the men looked pretty seasick.

"It's the port boiler, captain—she's leaking like a scuttle scow. We're losing tons of feedwater. With our water consumption climbing, we'll have to cut that boiler out in a few minutes. That means proceeding on one boiler."

Captain Towns' steel-gray eyes shot a penetrating look at the chief. Finally he querried, almost in a whisper, "you can patch her up, can't you?"

"I don't know," came the unsteady reply. "It's the economizer U-tubes. They're leaking at the U ends at that. Makes it pretty tough, Captain. If only we could weld, but we've no welding equipment aboard." The chief looked anxiously at the angry waves pounding the ship on the weather side.

"Suppose you can't fix her?" asked the skipper. "You know what a big blow means in these waters."

"Let's not walk that plank now," moaned Penelli, tossing his cigarette butt to leeward. "I'd better scoot below. We'll have to reduce speed in a few minutes, then take that boiler off the line and see what's what inside her."

The *Cyclops* was a steam-turbine reduction-gear job, known as the AP-2 type Victory Ship. She had been built for the Merchant Marine in 1944, then assigned to the Navy for convoy duty. Shortly after D-day, the

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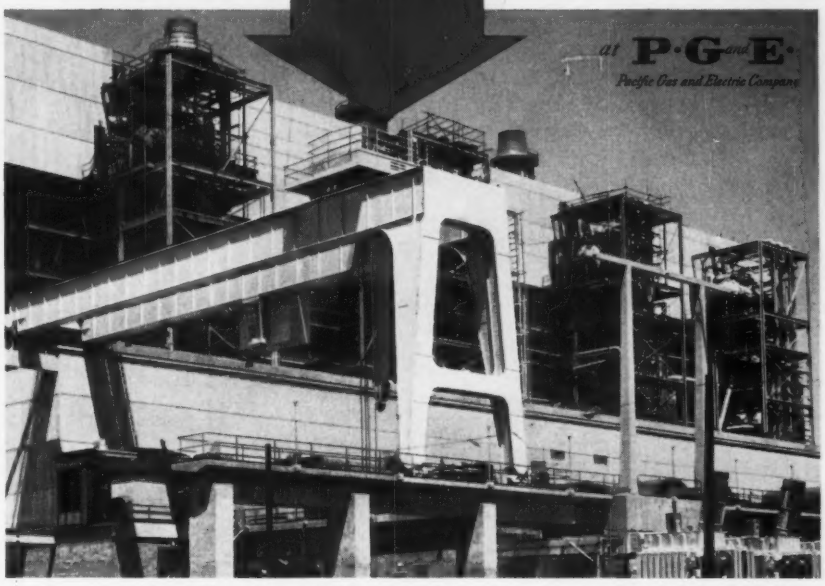

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Super Seal is a combination of non-frictional metal particles and asbestos fiber . . . graphite impregnated and bonded together with special resilient binders to meet specific service conditions. It contains no volatiles. Nothing can be squeezed out or driven off under heat. It will not dry out or harden.

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JOHN CRANE **CRANE PACKING COMPANY**
OFFICES IN ALL PRINCIPAL CITIES

Marmaduke

Begins on page 130

Cyclops had been bought by the Nippon-Cathay Steamship Co. They changed her name; now, in Jan '46 with the war over, she was supplying our occupation personnel in Japan.

Proceeding to Seattle after being decommissioned, the *Cyclops* was loaded down to her Plimsoll mark with general cargo. For good measure her fore and aft decks were piled high with lumber. Then on sailing day 21 passengers came aboard. Eight of these were female Red Cross personnel, the rest an assortment of males—some civilians, others officers of the Army, Navy and the Marine Corps.

Captain Towns had been her skipper during the war and now had command as a Maritime Service officer. He was a stickler for Navy routine and ran the *Cyclops* as if she were still Navy. Example was the intercom. It wasn't Merchant Marine, but the system had been left aboard and the captain used it often.

A half hour after the council of war, the port boiler had been cut out, pressure released and a staging lashed up under her economizer. The *Cyclops* lurched suddenly to starboard, throwing Penelli and his second assistant, who were examining her U-tubes, against an open economizer door.

"She can't be repaired," gulped the chief, shaking his head as the *Cyclops* righted herself. "Hell, welding's the only solution, so we'll have to keep running on No. 2 boiler and hope she doesn't go haywire."

Two hours later a force-7 wind was howling and the *Cyclops* was laboring through mountainous seas. Off her starboard side could be seen the glistening ice-capped Aleutian Islands. The heavily loaded vessel bravely kept her nose into the gale, trying to hold her own at reduced speed on one boiler while wallowing in the vicious seas.

In the dining room the officers and only a few of the more seaworthy passengers showed up for dinner. The others were in their rooms, fighting seasickness or praying for instant death to take them out of their misery. The *Cyclops* had settled down to a steady succession of 15-deg rolls,

For more facts circle 278 on Reader Service card, p 103

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Unlike conventional electrical or pneumatic valves, new electro-hydraulically operated Hydramotors remain in last position when power is removed – until energized to trip. Designed by General Controls for use on the main gas and oil fuel lines of power plants, these Hydramotors are especially built and internally wired to close tightly in just one second – *but only on operator command.*

This eliminates the possibility of shutdown in case of power source failure...keeps flow to boilers constant at all times because these valves are electrically operated. No air pressure or pneumatic piping is required.

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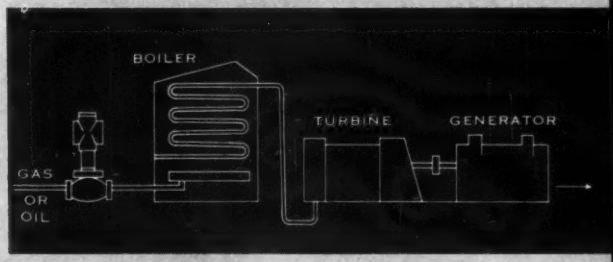
VALVES FOR POWER PLANTS



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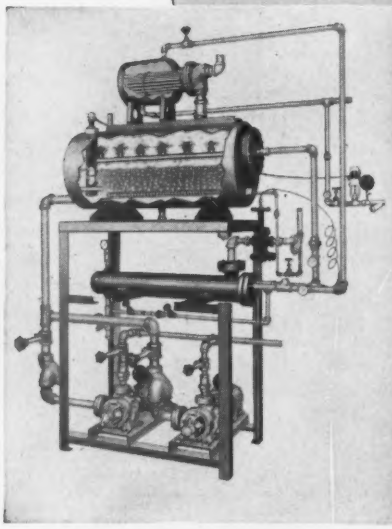

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Name_____

shuddering after each roll like some gigantic sea monster as she shed tons of green water.

At the end of the long forward table sat a civilian passenger with an attractive nurse on either side. He was a husky 6-footer with a few inches left over for good measure. At the moment he was replenishing three glasses of his own brand of seasick medicine labelled Sandpaper Gin. It must have been a good remedy, for the girls were giggling and suddenly all three busted out laughing. These party-makers were having too jolly a time to bother about the plight of the *Cyclops*.

The captain and chief engineer entered the dining room through opposite doors at almost the same instant. They sat down at the long table where the officers were quietly eating. Little was said at this end of the table; tension hung heavy.

"How's your good boiler holding up, Chief?" ventured the captain. "We got a radio message that this gale will get up to force 9 or 10. I hope we'll be able to hold our own with only one boiler."

Penelli's reply was a worried frown. "Well," continued the captain, "I figure we'll get into her worst part about this time tomorrow evening. You'll have a few hours to fix that sick boiler."

"We've no welding equipment, so our only hope would be to bypass the economizer, but that's a major operation because we'd have to install jury-rig piping," replied the chief, dejectedly. "And we could never finish it by tomorrow evening. Drilling through the leaks in the U-bends, then pipe tapping and plugging isn't practical either because the metal is too thin over a wide area and the plugs may not hold. . . ."

"But we *need* that other boiler, Chief," pleaded the captain, suddenly alarmed. "Suppose your good boiler conks out?"

At this point the passenger sitting between the two nurses suddenly blared in a foghorn voice, "what's this scuttlebutt about a leaky kettle?" But before the captain could reply he continued, "I'm the best boiler fixer on the seven seas. The

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Marmaduke

Begins on page 130

name's Marmaduke Surfaceblow and I'm on my way to handle a salvage job in Kobe for Merritt, Chapman & Scott. Want me to take a crack at her?" Annoyed eyes turned toward the noisy passenger.

"Sure, tell Marmy what's wrong with your nasty ole putt-putt, Chief," trilled one of the young ladies gleefully. "He can fix anything; he told us so himself." That brought a chorus of laughter from the three. But the others were clam-faced.

The chief studied this blustery passenger for a moment. Mr Surfaceblow's well-tanned face bristled with a steel-brush mustache. In his strong white teeth he chomped a long black cigar, which he kept well supplied with induced draft. Penelli looked questioningly at him. Evidently clutching at a straw, he started to brief this character on the problem.

Marmaduke seemed preoccupied with the ladies and his bottle. But as Penelli finished his tale of woe, Marmy drained his glass, then mumbled to the ladies, "after I fix those economizer leaks I'll have to plug the leak in these Sandpaper Gin Bottles." Looking towards the ship's officers he said almost absent-mindedly, but with authority, "gentlemen, all you have to do is weld those U-tubes."

"But there's no welding equipment aboard," snarled the chief irritably.

"BILGEWATER on welding equipment; if you don't got you MAKE," roared Marmy in his gravelly voice. "And Captain," continued the 6-ft-plus hurriedly, "if I fix your boiler you'll have to blow these lovely ladies and myself to the grandest clambake the Imperial Hotel in Tokyo has ever seen."

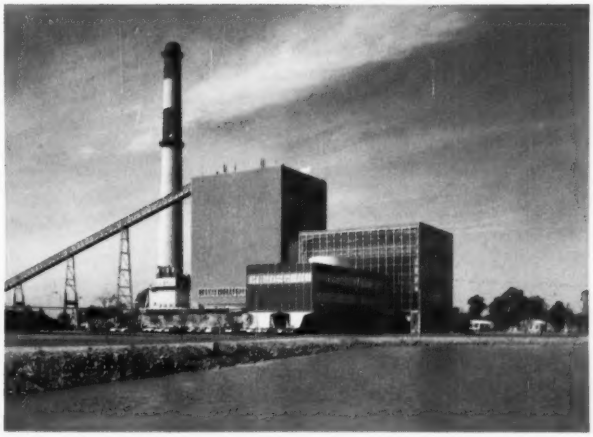
For a second there was absolute silence as the *Cyclops* again rolled bow down and to starboard. Then she shuddered convulsively as her propeller lifted high out of the water. Everyone instinctively grabbed for the table and his dishes. The captain glanced quickly at the chief engineer, then answered, "if you can weld those tubes you better do it quickly. And if you do I'll pick up the tab for a party you won't forget."

continued on p 140

For more facts circle 282 on Reader Service card, p 103

circle 283 on Reader Service card, p 103 ➤

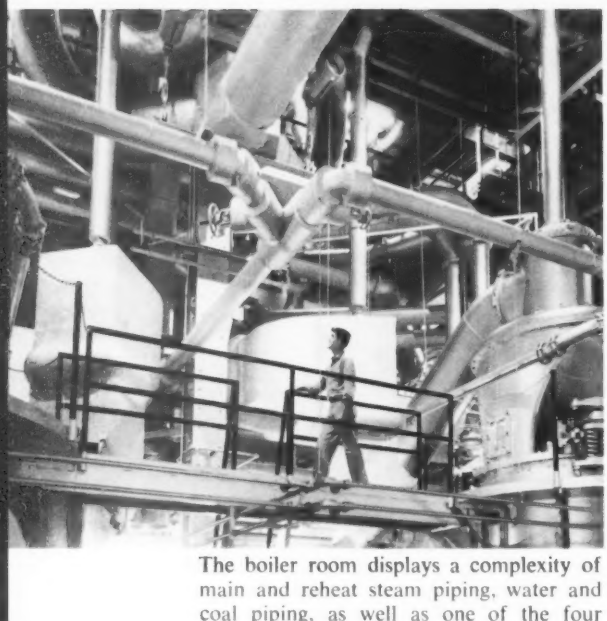
Efficient new power station gets striking decor



This new generating station, a United Engineers project, features high efficiency at low cost and is an excellent example of what long experience in power plant design and construction can accomplish. It produces one kw of electricity for less than 7/10 of a pound of coal and at full load consumes about 1300 tons daily. Power leaves the substation and enters the transmission system via underground oil-filled pipe-type cables. This attractively landscaped station can provide for the electric needs of a large, heavily populated area.

This 150,000 kw turbogenerator is 70 feet long and weighs more than 450 tons. Its generator, liquid cooled, is rated at 192,000 kva. The stator weighs over 130 tons.

Milestone in power plant design



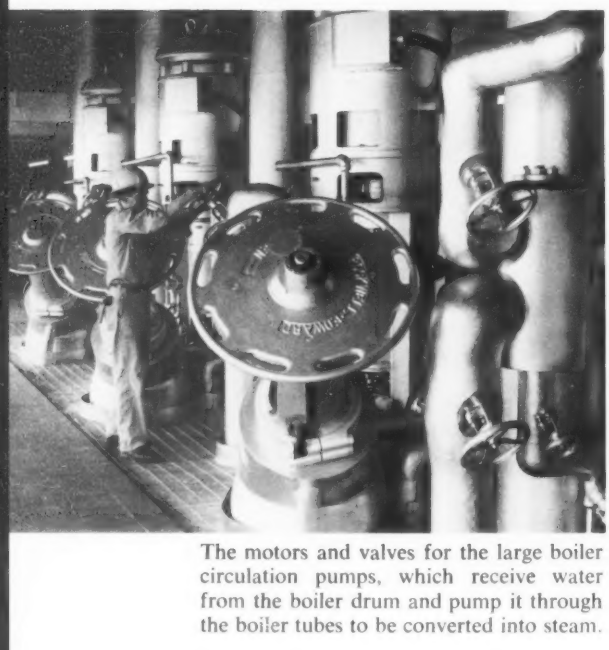
The boiler room displays a complexity of main and reheat steam piping, water and coal piping, as well as one of the four mills for pulverizing coal.

The station uses a forced-circulation-type boiler designed to produce 1,150,000 pounds of steam per hour at 2000 psig, 1000 F, and 1000 F reheat. Water from city mains is treated for use in the boiler. Water for cooling purposes is pumped through the screenhouse into the condenser at the rate of 100,000 gallons per minute.

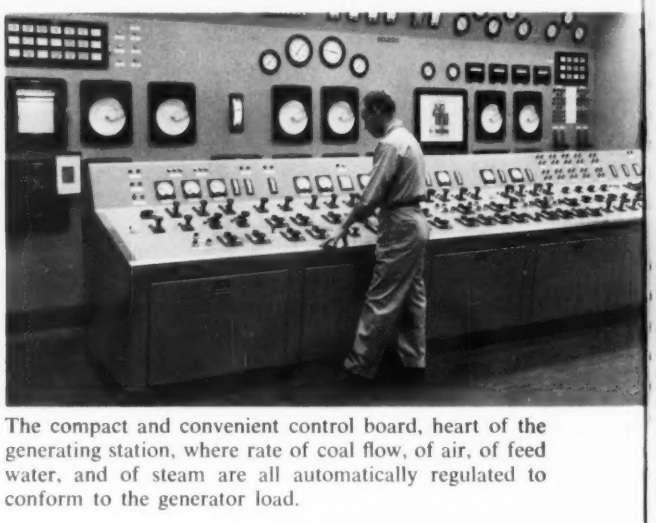
Virtually no dust or ash particles are blown out of the stack. The station uses a system of mechanical and electrostatic precipitators operating at 99% efficiency. The load-dispatching center, some distance away, directs generator operation by microwave communication. The antenna is located high on the stack.

★ ★ ★

From coast to coast, United Engineers has served on power projects of every magnitude and has repeatedly demonstrated the time and cost-saving advantages assured through efficient coordination of engineering design, purchasing, expediting and construction. The number of new assignments we receive from clients previously served is proof of the confidence placed in us. Why not benefit from our background of over 75 years' experience as designers, construction engineers, and engineering consultants.



The motors and valves for the large boiler circulation pumps, which receive water from the boiler drum and pump it through the boiler tubes to be converted into steam.



The compact and convenient control board, heart of the generating station, where rate of coal flow, of air, of feed water, and of steam are all automatically regulated to conform to the generator load.

UNITED ENGINEERS

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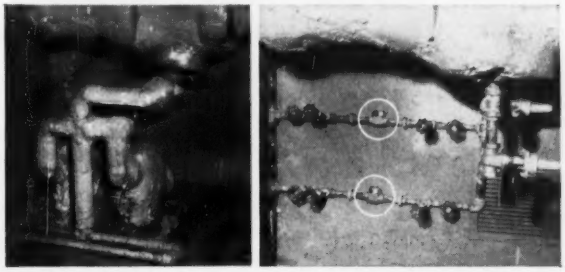
Printed in U.S.A.

SARCO TOPICS

How major New York office building solved steam trapping problems through trap standardization

Recently, the Office Building at 625 Madison Avenue, New York, — erected in 1931 and comprising 420,000 square feet on 17 floors — discontinued its own steam generation and switched to district steam. The changeover made the inadequacies of old bucket and float traps more apparent than ever, and afforded an occasion to modernize trapping. Here's how major improvements were made.

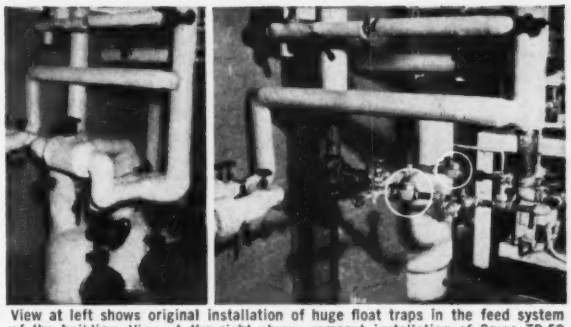
The first problem was maintenance. All maintenance had to be done at night or on weekends, at overtime rates, because the system could not be shut down during business hours. Frequent breakdowns added to maintenance costs. After the installation of Sarco Thermo-Dynamic Steam Traps, Type TD-50, trap maintenance — and therefore maintenance costs — have been reduced almost to zero. The engine room crew are now free for other jobs, and savings in both regular and overtime manhours are considerable.



Left picture shows the steam service main from the street, with massive float trap installation. Picture at the right is view of installation after the changeover to TD-50's (circled).

The second problem was water-hammer, caused by passage of live steam into return lines when traps failed open. (When traps failed closed, water accumulated in steam supply mains and equipment.) Installation of TD-50 steam traps ended waterhammer and consequent damage to equipment, because the TD-50 discharges condensate as rapidly as it is formed and prevents steam from entering the return system.

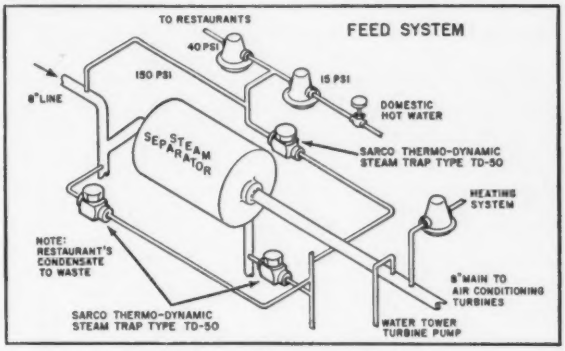
The third problem was live steam loss. Live steam, discharged into the return lines, not only represented a great waste of heat energy, but caused waterhammer in the return, and raised the condensate temperature to an excessive level. (Incidentally, although the building's district steam system is, of course, not faced with this problem, hot condensate passing through condensate pumps can damage pump seals.) These problems are eliminated through the use of TD-50's. No steam can be blown into the return main because the TD-50 shuts off *positively*, blocking any possibility of live steam being discharged into the return. Savings are considerable.



View at left shows original installation of huge float traps in the feed system of the building. View at the right shows compact installation of Sarco TD-50 Steam Traps (circled).

These benefits were achieved by replacing bucket and float traps with Sarco Thermo-Dynamic Steam Traps, Type TD-50, matched and correctly sized to the application. For example, many ½" bucket traps were replaced with ⅜" TD-50's, which have ample capacity for the job.

The TD-50's pressure range of 10-600 psi made it possible to standardize on one steam trap for a variety of applications that formerly required traps of many different types and pressure ratings. Finally, changeover took only 30 minutes per trap for each compact TD-50 installation.



Schematic hook-up of the converted feed system.

The success of this TD-50 installation led Collins, Tuttle Co., Inc., managers of the building, to substitute Sarco Thermo-Dynamic Steam Traps for competitive bucket traps in two other major New York buildings.

For more information on Sarco Thermo-Dynamic Steam Traps, contact your Sarco Sales Representative or district office, or write.

2165

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STEAM TRAPS • TEMPERATURE CONTROLLERS
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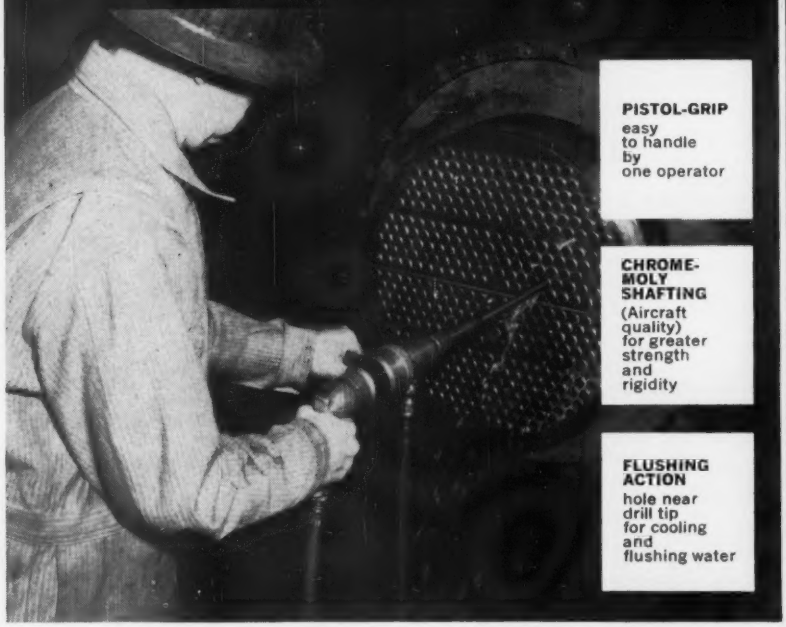
lightweight! air-driven!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easy to handle by one operator
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FLUSHING ACTION
hole near drill tip for cooling and flushing water

for condenser and heat exchanger tubes

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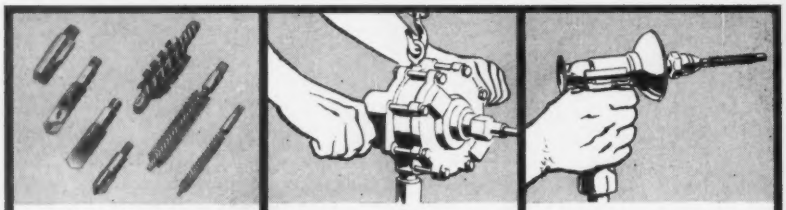

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Brushes for light deposits. Four types of drills clean light, hard-heavy, hard-light, and gummy deposits.

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ELLIOTT JIFFY GUN
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Y1-3

Marmaduke

Begins on page 130

"A deal," bellowed Marmaduke, blowing a cloud of smoke to the overhead. "This being a Merchant Marine ship, she had a degaussing system for repelling magnetic mines; is the gear still aboard, Chief?"

"Why yes—yes it is," stammered Penelli slowly, caught off guard. "But the cables aren't wrapped around the hull anymore."

"We don't need the cables," barked Marmaduke. "All we have to do is start up the degaussing generator, cut her back with the rheostat to give me an open-circuit voltage of about 30 volts. Then I'll have to fiddle around with some scrap to get the right heat—figure I'll need about 80 to 100 amp. I'll get an idea of the volt-amperage characteristics of this rig. And we'll hook up our leads to give us reverse polarity. We may burn up a lot of rod, but we can spare that more than tube metal.

Marmaduke was mostly talking to himself, mentally picturing the set-up he'd need; the faces aroung suggested dead fish. Only the chief had been looking a little closer to cheerful; but at the mention of rods he sighed, "and just what do you plan using for welding rods?"

"All these wartime-built tubs have lengths of welding rod stuck in odd places," shot back Marmy. "You'll find them on beams and ledges, in the bilges, almost in every hidden corner you look. Hell, I'll bet you even have a few dozen pothooks in your paint locker made of them. And chances are they're general-purpose rods, E6020—they used a lot of that wire to glue these sampans together. That economizer-tube material is sure to be SA-83, but in any event it's low-carbon stuff and'll take a weld good enough to bring us in."

"I think he's right about those rods," piped up the first assistant suddenly. "I'll run down to the paint locker and see."

"How about a welding shield?" asked the second assistant thoughtfully. Just then the steward walked into the dining room.

"A maiden's prayer," roared Marmaduke. "Ahoy there, steward, bring us an empty 5-gal milk can. We'll cut her in two, knock a hole into one

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For more facts circle 286 on Reader Service card, p 103

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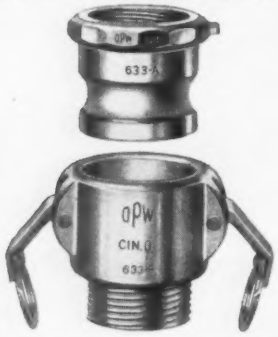
WITH KAMLOK QUICK COUPLERS



You save production time . . . when you replace time-wasting hose and pipe connections with Kamlok Quick Couplers. No tools needed. Your operator can do the job himself. Just fit together and pull the two cam arms down. Use them wherever your hose or pipe connections are periodically uncoupled (once a week or oftener). We probably have one to fit your needs. Why not send for more information? Inquiries are invited.

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Babbitt

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ON EVERY VALVE

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- They simplify pipe layout.
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- They save time and money.
- The first cost is the only cost (no maintenance).
- They are packed completely assembled (one to a carton), with easy-to-follow instructions.
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Babbitt STEAM SPECIALTY CO.

2 Babbitt Square, New Bedford, Mass., U.S.A.

circle 288 on Reader Service card, p 103

Marmaduke

Begins on page 130

side of the bottom half and tape in a piece of smoked glass from one of the boiler peepholes." Before the steward could answer, Marmaduke rasped, "now let's go below. I want to get started. I don't like the way this rust bucket's riding with only one boiler down there pushing out steam."

Below in the machine shop the first assistant held a fist-full of welding rod. "I've got men combing every corner of the ship," he hurriedly explained to the chief. Marmaduke picked up a small C-clamp. After filing a bright spot, he scraped the insulation from one end of a long electric cable and taped it to the clamp. Then he wrapped the clamp well with asbestos, rubber tape and electrician's tape. Next he gripped a welding rod with the clamp.

Rubber gloves were brought from the sick bay; over them he pulled leather work gloves. A pair of rubber boots from the slop chest had him well insulated. After the first assistant made connection from an economizer U-tube to ground, Marmy went to the generator and adjusted the voltage, then slipped the welding shield over his head. It fit, after a fashion. He struck an arc on some scrap metal, then monkeyed with the voltage for the right heat.

"She works," roared Marmy, jerking off his shield. "Now let's get hot." By then the crew had filed shiny the leaky end of each U-tube.

Crew members from chief engineer down had turned to. Two of them stood alongside Marmy bracing his body against each roll so he could weld. Others stood by, handing up welding rods.

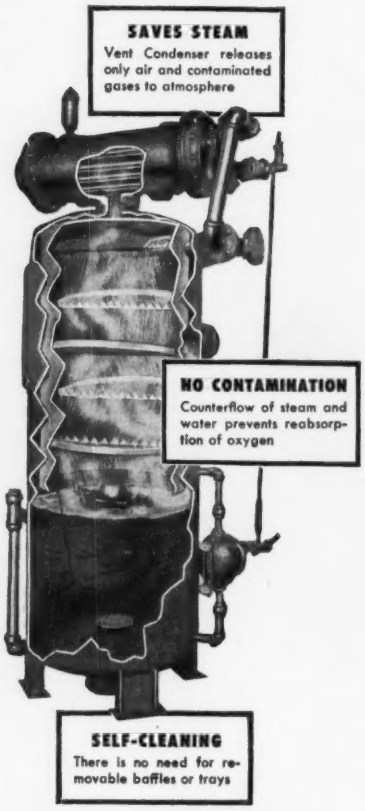
The steward came below with sandwiches and steaming coffee to make up for the uneaten meals in the dining room. This was a one-for-all, all-for-one project—they were in the same boat and they knew it.

Finally the job was finished. Over a dozen holes of various sizes had been welded over with a layer of welding metal. The hot boiler was lit off with one burner, then steam brought up; 18 minutes later she was cut in and none too soon. By then

Stop Corrosion

in boilers, steam and return lines . . .

with this Stickle deaerating feed water heater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Cuts the cost of steam

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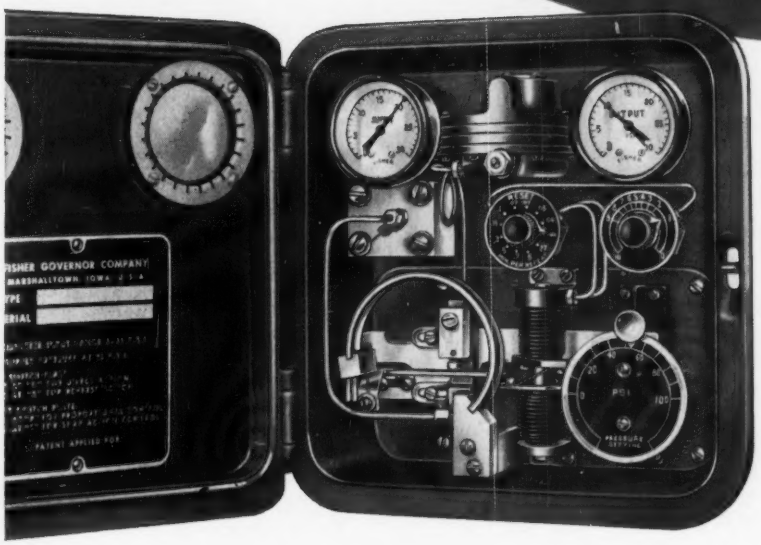
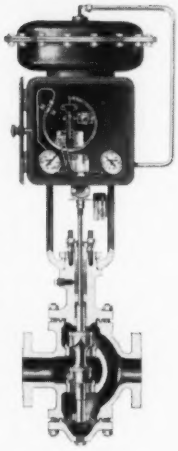
the Fisher/man shows how to get.....

Accurate pressure control in spite of demand changes



WIZARD II
Pressure Controller



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The original Wizard I Pressure Controller is still available for those applications not requiring volume relay or reset features. The simplicity of a self-operated regulator and the accuracy of a pilot or relay operated regulator are found in the Series 4100U. This is, unquestionably, the reason for the continued popularity of the Wizard I series.

●Faster response to pressure changes provided by volume relay ● Pin-point control made possible by reset feature, adjustable from .005 to 1 minute per repeat ● Wide pressure ranges handled by brass, steel or stainless steel Bourdon tubes for 30 to 15,000 psi, Bellows assemblies for pressures below 30 psi and vacuum ● Easily reversed from direct to reverse action without additional parts ●Universal mounting on a wall, panel, or on yoke of control valve ●Compact construction consists of two sub-assemblies encased in weatherproof die cast aluminum housing, either can be removed without disturbing case mounting. *Write for bulletin No. D-4150B or D-4100 on Wizard I.* Fisher Governor Company, Marshalltown, Iowa. Plants in Woodstock, Ont., Rochester, England. Butterfly Valve Division: Continental Equipment Co., Coraopolis, Pa.

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When live steam contacts the bellows of a Nicholson Trap, the pressure inside the bellows equals the pressure outside. With both pressures balanced, the spring action of the bellows closes the trap. When condensate collects around the bellows, pressure inside drops causing outside pressure to compress the bellows and open the trap.

Briefly, this is true balanced pressure and is the operating principle of Nicholson Thermostatic Steam Traps. That's why they discharge condensate and air quickly, positively and intermittently . . . and why they help you get full thermal value from every pound of steam and full productive value from your steam equipment. They provide greater capacity, too . . . up to six times that of ordinary traps. And there's no steam waste either, because seats and valves are of hardened stainless steel, finely ground and accurately lapped for sure, tight shut-off.

As for maintenance, it's practically nil . . . and here's why. In this simply designed trap there is only one moving part. No links, pins, pivots or levers to go wrong. No adjustable orifices to stick, wear or become clogged. No need for valve and seat changing. In short, no downtime because of trap failure.

Naturally, plus efficiency like this does not come at "bargain" prices. You can get cheap traps, of course. But remember this: *price* only shows up on the dealer's shelf; *value* is what shows up on your lines . . . and with Nicholson Traps it shows up in discharge action you can rely on to keep temperatures high and even for full thermal efficiency at point of steam use . . . efficiency that can often increase production as much as 20%.

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Marmaduke

Begins on page 130

the vessel was barely holding her own against the blockbuster waves and roaring head gale. Porthole deadlights had been battened down and life lines strung on deck—no one was allowed topside.

Cyclops limped into Yokohama Bay 16 days later with a sorry-looking group of passengers and crew. She was seven days late but she *had* arrived. There were a few broken limbs and two lifeboats and a funnel from her port side were missing. So was all the lumber from her forward deck. Most of her wheelhouse glass was gone. Soon as the anchor went down an American Bureau of Shipping inspector came aboard with the line's agent. The captain had radioed ashore about the repair. After he'd checked the boiler, the inspector's only comment was, "these welds look good as a certified welder's. I can hardly believe my eyes."

That night the captain's party at the Imperial Hotel was a whooping success. The ABS inspector and some of the ship's officers and passengers were on hand to celebrate. So were several reporters from a Tokyo paper who had heard about the ingenious repair that brought the ship safely, although somewhat battered, into port.

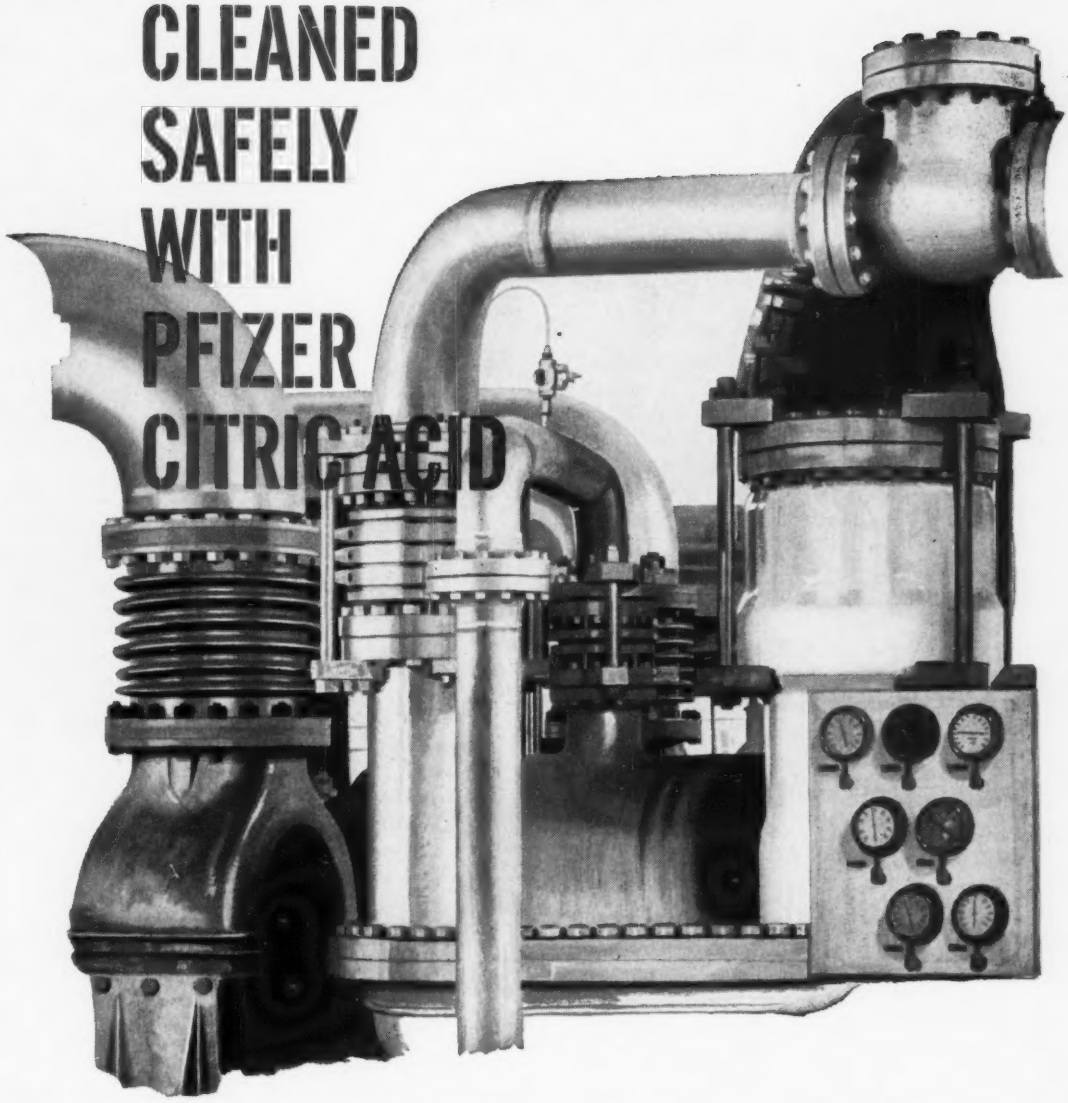
After everyone was well ballasted with beef sukiyaki, bamboo shoots, rice, and thoroughly saturated with saki, the captain arose, called good-naturedly for silence.

"Excuse me for asking you to tear yourself away from the ladies," he addressed Marmaduke. "Because you fixed our leaky tubes," beamed the captain with a twinkle in his eye, "here's a surprise: a case of your favorite seasick remedy to weld us in everlasting friendship. I'm sure all of us here agree that *you* are the best seasick remedy the *Cyclops* ever had. Everyone applauded.

Marmy walked forward to receive the case of Sandpaper Gin as bulbs flashed and cameras clicked.

"And here's something to weld *our* friendship," warbled one of the young ladies as she threw her arms impulsively around her hero and planted a 99-decibel superheated smack on his kisser.—*SME*

CLEANED SAFELY WITH PFIZER CITRIC ACID



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For more facts circle 292 on Reader Service card, p 103

Powerscope . . . A selective look at

France's largest hydro plant

First two of six 113,000-hp 88,000-kva turbine-generators went into service in mid-December at the La Bathie-Roseland hydroelectric plant in the French Alps near Albertsville. When all six units run in late 1961 the station will be France's largest with annual output of about a billion kwhr. The Roseland Dam produces a 3700-ft head on the plant. Arch-dam section towers 492-ft high with 755-ft span flanked on each side with buttressed wings for a total crest length of 2500 ft. Reservoir holds 3600-million cu ft. (*McGraw-Hill World News*)

Surgically clean plumbing

Paul Hardeman, Inc have a multimillion dollar contract to build propellant-loading systems for Atlas intercontinental ballistic missiles. The systems use high-pressure forged stainless-steel pipe fittings supplied by H K Porter Company, Inc, to be installed in subterranean pads at Air Force bases in California, Kansas, Nebraska, Oklahoma, Texas, New Mexico and New York. More-exacting sanitary conditions must be used in assembly than in most hospital operating rooms. No particles larger than 150-micron dia may remain in the piping; larger specks of dirt might cause a premature explosion during missile loading. Workmen wear surgical gowns, caps, gloves and overshoes to insure cleanliness in the dust-free humidity-controlled assembly rooms for the equipment.

Another "biggest" on line

A 500-mw General Electric company steam-electric unit started commercial operation on Dec 31, 1960 at the Philip Sporn Plant of the Ohio Power Company, boosting plant capacity to 1100 mw. This is a twin of the unit started last July at the Indiana & Michigan Electric Company's Breed Plant. High-resistivity water flows through hollow copper strands of the generator's stator for direct cooling. A 3-million lb-per-hr Babcock & Wilcox steam generator supplies steam at 3500 psig and 1050/1050/1050-F for two reheats. Heat rate expected: 8500 Btu per kwhr.

U.S. minerals rise

Mineral output in U.S. reached $17.8 billion in 1960, 4% above 1959 and second only to 1957's $18.1 billion. Fuels reached $12.1 billion in 1960 compared to $11.8 billion in '59. Crude petroleum declined by 5-million bbl from 1959 to a total 2569-million bbl in 1960. Price at well rose 2¢ to $2.92 per bbl. Natural gas increased 5% to 12,692-billion cu ft. Average value at wellhead rose by 0.7¢ to 13.6¢ per thousand cu ft. Bituminous coal and lignite rose 0.7% to 415-million tons in 1960. Average value dropped by 4¢ to $4.73 per ton at the mine. Pennsylvania anthracite dropped by 13% to 18.1-million tons. Uranium ore rose from 6.9- to 7.9-million tons in 1960 with value increase from $141 to $156 million. High-purity silicon jumped by 20,000 lb to 90,000 lb in 1960 because of growing demand for silicon transistors, diodes and rectifiers. Grade-1-silicon price dropped from $330 to $200 per lb. Germanium use increased during 1960; price remained firm. Tellurium demand increased, price rising from $3 to $4 per lb; no new sources were found by Bureau of Mines or industry.

Largest man-made diamonds

General Electric Company has made diamonds over a carat in size. The dark stones do not yet have enough mechanical strength for industrial uses. First diamonds made in 1955 from graphite were one-thousandth carat in size, about like fine grains of sand. This size is used in industrial cutting, grinding and polishing. Commercial production of the small diamonds began two years after laboratory production. Millions of carats of the small diamonds have been made in Detroit since 1957. Excellent industrial-quality diamonds of 1/10-carat size can be made in the lab but are not yet available commercially. Industry uses this size for metal-bonded-diamond wheels and saws. Diamonds in full-carat sizes are used for drills, dressing tools, dies and single-point cutting tools.

Water for rain-shadow land

Two pumping stations lift water some 330 ft through 23 miles of canals into the semidesert land in the San Joaquin Valley west of Fresno, Calif. This privately financed irrigation system will reclaim almost 20,000 acres of arid farm land that receives only five to seven in. of rain annually. Main pumping station has three 900-hp and two 700-hp General Electric motors driving Byron Jackson pumps lifting 69,600-gpm water nearly 200 ft. Second station has two 600-hp and three 300-hp pumps raising canal water an added 130 ft at 53,900 gpm. Area development began in 1945 using deep-well water. Reclamation was curtailed in 1950's because of poor water quality and near exhaustion of underground reserves. Present reclamation receives up to 93,300 acre-ft water yearly.

this month's power-field happenings

B G A SKROTZKI, Associate Editor

New gas line under way

The first pipe section was lowered into the ground at the Oregon-California border in late December for the 1400-mile $300-million Alberta-California natural-gas pipeline. When completed in about one year the line will bring natural gas from wells in the eastern foothills of the Canadian Rockies through Alberta, British Columbia, Idaho, Washington, Oregon and California. Line will deliver 415-million cu ft of gas per day, about 22% of total supply to the PG&E service area.

It's official

Tennessee Valley Authority awarded a contract to the General Electric Company for two 800-mw steam-turbine-generators, the largest ever to be built, at a cost of $30.4 million. The contract was evaluated as exceeding the lowest foreign bid by less than half of the 20% margin allowed by TVA to domestic steam-turbine builders. The first unit is planned for Sept 1, 1964 operation, the second to run by Sept '65. Each of the units will have steam generators burning more than 2-million tons of coal yearly. Boiler bids were received in January. The price for one 800-mw unit would have been $21 per kw, but the package of two lowered the cost to $19 per kw. Capacity of TVA system is now 11,385 mw—not including the 500-mw unit on test at the Widows Creek Plant.

New electric records

Edison Electric Institute estimates for 1960: total utility capability, 175.9-million kw; industrial-plant capability, 17.1-million kw; capacity reserve above 139-million-kw peak, 25.5%; utility output including Canadian imports, 764.8-billion kwhr; industrial-plant output, 85.7-billion kwhr.

New sound laboratory

Allis-Chalmers has opened a new sound-research lab at its Norwood Works in Ohio. While developed to test its own products, lab will be available to others for sound research. The lab will be able to test ac motors up to 900 hp and dc motors up to 300 hp. The reverberant sound chamber has inner walls and ceiling of 8-in. poured concrete on a separate foundation surrounded by outer walls of 8-in. concrete block with a 6-in.-minimum air space between. The hard-surfaced double walls with separate foundations, along with an isolated pad for mounting test equipment, supply main methods of sound attenuation, the difference between outside and inside noise levels. While a 10-decibel difference is adequate for normal testing, the new chamber will have 40- to 50-decibel attenuation.

New pumped-storage hydro

Public Service Company of Oklahoma has filed application with the FPC for a license for a proposed $22.1-million pumped-storage project near the Keystone Reservoir in Osage County, Okla. Army Corps of Engineers is building the Reservoir. Public Service proposes to build an earth dam 5150-ft long, 160-ft high across a canyon at the head of Sand Creek, an Arkansas River tributary. The 5800-ft earth-dike dam would store 7500 acre-ft of useful water. Water would flow from the high-level reservoir through a 910-ft-long canal to a forebay and then through a vertical shaft to a horizontal tunnel 915-ft long, on to the powerhouse through four steel penstocks. Plant and its four reversible 50-mw pump-turbine-generators would nestle in a cove of the Keystone Reservoir.

Japanese expansion

Ministry of International Trade, Public Utility Div, has authorized construction of six oil-burning power plants with ten generators totaling 1997-mw capacity and four coal- and oil-burning plants with four generators totaling 562-mw capacity. This plan is subject to approval of the National Electric Resources Development Council. The Japanese industrial 10-year program is expected to double the country's gross national product. Government plans to import one 325-mw generator from the U.S. for Kansei Electric Power Company, manufacturer still undecided, and two boilers for Tokyo Electric Power Company from Babcock & Wilcox Company. (*McGraw-Hill World News*)

New line proposal

Southern California Edison Company and the California Gas Transmission Company propose to bring new gas supplies into Southern California. Gas, to be piped from Texas and northern Mexico, would also be available to help local gas companies meet peak demands. The pipeline would be 1600-miles long, running from the Texas Gulf Coast to Reynosa, Mexico, then northwest to the Los Angeles area. The $225-million project could be running by July 1, 1962. Line would provide up to 455-million cu ft daily, about 20% of Southern California's present supply. (*McGraw-Hill World News*)

-Installs
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Self-Aligning
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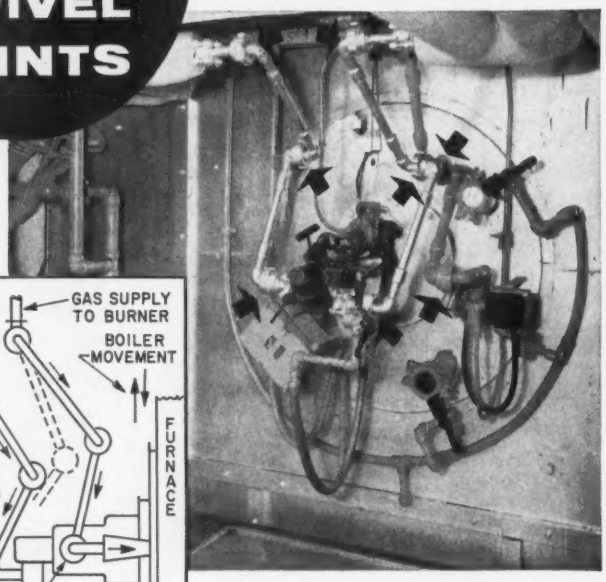
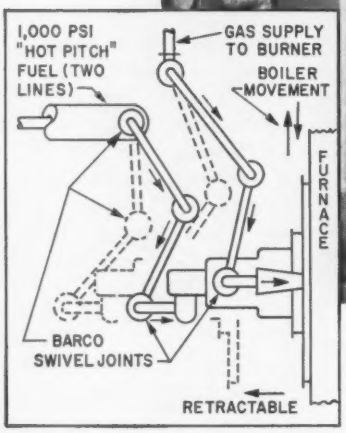
SAFETY
for Burners
handling 450° Fuel
at 1,000 psi





The above photograph shows three flexible "dog leg" piping connections for fuel fired in a large eastern utility steam generating station. The arrows point to Barco "Self-Aligning" Swivel Joints. The schematic diagram at left shows how the burner installation is readily retractable and also is flexible to allow for boiler movement.

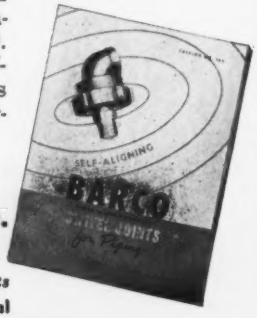
Power Plant Uses Steel Pipe
for "Flexible Connections"

THE idea of using steel pipe, instead of hose, appeals to many engineers—especially where fuel is being handled at high temperature and pressure.

In the boiler plant shown above, heavy pitch, obtained from a nearby oil refinery, is pre-heated to 450°—500°F and pumped at 1,000 psi to the burners of the steam generators. On each burner, two 1″ lines feed hot pitch; a third 1½″ line (painted gray) handles natural gas for auxiliary firing.

Each line is fitted with three Barco Type S All-Steel Swivel Joints with welded connections. Periodically, all lines are purged with 150 psi steam.

With a total of 642 Barco joints installed, only one joint has required any maintenance in two years of service. One of the big advantages of these joints is that they have NO BALL BEARINGS. They don't bake dry at high temperatures. NO LUBRICATION REQUIRED. Another big advantage is that they are *self-aligning;* this eliminates binding and simplifies and speeds up pipe fitting. For detailed information, ASK FOR CATALOG 265D.



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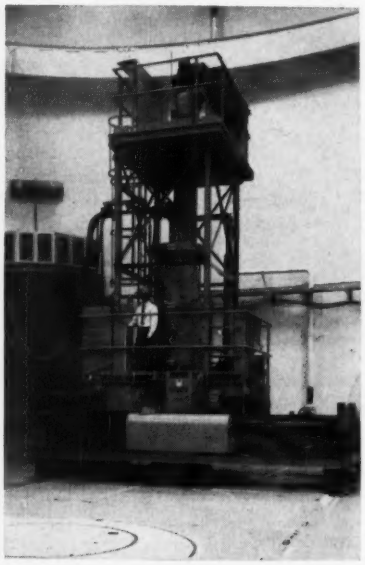
The Only Truly Complete Line of Flexible Ball, Swivel, Swing and Rotary Joints
In Canada: The Holden Co., Ltd., Montreal

Use atom bombs to open up low-grade coal deposits

We need a broader philosophy in thinking up uses for nuclear energy. So said J J Grebe, director of nuclear and basic research for Dow Chemical Co, in a speech to the AIEE. One proposed application: use atom bombs to set low-grade fossil deposits on fire. Once afire, the bombed mines can produce steam to power huge electric-generating plants. Another thought: try modern-day alchemy, converting minerals in the ground to other chemical products via atomic energy.

Nuclear energy, thinks Grebe, is the cleanest and safest form of energy we've yet learned to control. But we have a public-relations job on our hands, making the non-scientist or non-engineer understand that, in the realm of industrial dangers, nuclear hazards are among the easiest to spot and avoid.



"Juggernaut" feeds atomic reactor

"Juggernaut," a giant 50-ton atomic-fueling machine, is reported on the rails and ready to roll at Atomic Energy Commission's atomic research

Begins on page 146

facility, Plutonium Recycle Test Reactor (PRTR). Nicknamed by General Electric engineers, the self-propelled machine is involved in a Hanford Lab research program on using plutonium as a fuel in power-generating atomic reactors.

Extending 25 ft toward the ceiling, the awkward-looking Juggernaut doesn't let its baby get hungry, GE engineers say. They've timed the process and found it takes the feeder only 36 seconds to pull a fuel element from a process tube. Carrying its atomic cargo, Juggernaut rolls back and forth on railroad tracks above the reactor core or nuclear furnace where the chain reaction takes place. It lifts an irradiated fuel element out of a reactor process tube and cradles it safely in its lead-lined innards to deposit it in a water-filled storage basin. Then it loads a new, unirradiated fuel element back into the empty process tube.

An operator astride Juggernaut directs its movement from an electronic control console, guides it down the tracks at speeds ranging from 40 ft a minute to a snail's pace of three in. a minute. Operator can pinpoint it within an accuracy of 1/10,000 in. over one of PRTR's 85 vertical process tubes. 13 inches of lead protect him from radiation.

GE expands Computer Dept

General Electric Company's Computer Dept is planning to open 11 data-processing centers and 10 additional sales offices in major cities across the nation. Expansion comes from an anticipated 33% increase in commercial - computer - equipment shipments within the next two years. GE's Computer Dept presently has two data-processing centers and 16 sales offices.

Five data-processing centers will open this year. Remaining six are scheduled for '62. First five will open in Chicago, New York City, Philadelphia, Boston and Cleveland. Those scheduled for '62 openings are in Minneapolis, Seattle, Atlanta,

ROCKWELL-REPUBLIC

V-5 gauges combine small size with big-gauge readability

TRY THIS "CUTOUT TEST"

For a true demonstration of the readability of Rockwell-Republic V-5 gauges, cut out the actual-size photo at the right. Mount it on any wall or panel board. Step back and see how easily the scale can be read, even from 10 or 12 feet away!

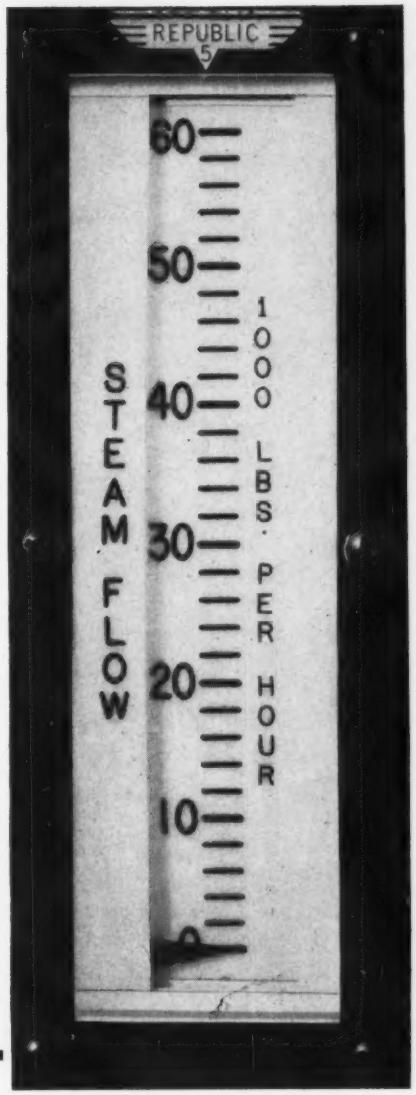
BIG-GAUGE ACCURACY, TOO

Compact V-5 gauges are equipped with electric receivers or full sized diaphragms, bellows, and helixes for maximum accuracy and sensitivity. Yet these Rockwell-Republic gauges require one-fourth the panel space needed for standard gauges.

GROUP MOUNTING INCREASES VERSATILITY

As many as eight gauges can be grouped in a single mounting case. Types can be mixed to meet individual panel requirements. Mounting is simple, too. Just a panel cutout is required in most cases.

There's a V-5 gauge for almost every process measurement. Mail the coupon today for the 12-page bulletin on these easy-to-read gauges, and for available literature on other Rockwell-Republic instruments, controls, and valves. RF-22



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For more facts circle 294 on Reader Service card, p 103

Stack specialists agree:

A. O. Smith glass-protected stacks are dollar sound... last up to 3 to 5 times longer than unlined steel stacks

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- **Glass is tough, durable**—shows remarkable resistance to impact or abrasion
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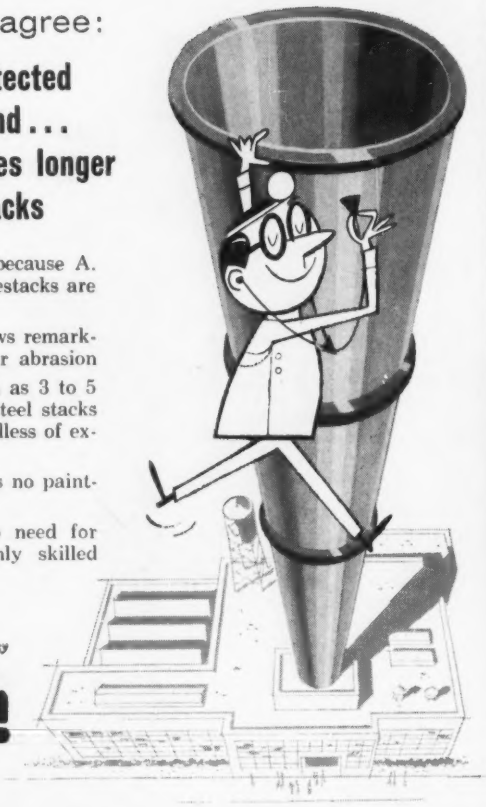

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For Steam, Air, Gas, Oil,
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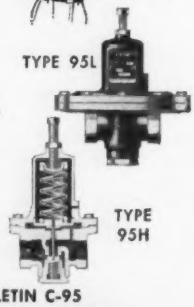
Low pressure, Type 95L is designed for outlet pressures from 2 to 30 psi; high pressure Type 95H for outlet pressures up to 150 psi. Small size makes this regulator particularly adaptable to installations having space limitations.

Available with Neoprene diaphragm and seat for temperatures to 150°F. For temperatures above 150°F. stainless steel trim is used. Available in sizes ¼" thru 1".

Quickly installed, easily accessible for parts replacement without removing from line.



FOR FULL DETAILS, REQUEST BULLETIN C-95

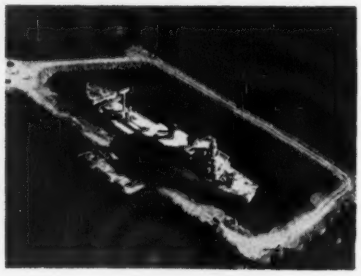
FISHER Controls

FISHER GOVERNOR COMPANY
Marshalltown, Iowa/Woodstock, Ontario

For more facts circle 296 on Reader Service card, p 103

Powerscope

Washington, D.C., Dallas and the San Francisco Bay area. Equipment in the new data-processing centers will be either the large-scale GE-210 or the recently announced medium-sized GE-225.



Ship brings floating power to missile-warning system

YFP-10, formerly a dry cargo vessel, has been turned into a floating power station to provide electricity for our vital Ballistic Missile Early Warning System. Propulsion machinery was removed and ship was filled with boilers, generators, evaporators, condensers. Now it's towed to where it's needed, moored while producing power. Burns and Roe, Inc, operates and maintains the seagoing station.

Independent of shore facilities, YFP-10 can go from "cold ship" to full power in 4 hr, operate up to 30 days without refueling. Normal boiler makeup is zeolite-softened fresh water from an arctic lake. In an emergency, a 20,000-gpd evaporator turns sea water into fresh makeup.

Three top-fired boilers supply 123,000 lb per hr steam at 650 psig, 830 F to three 3600-rpm 16-stage impulse turbines. Any excess h-p steam will be converted to saturated steam for heating the base.

Electronic-age pied piper gets the rats out fast

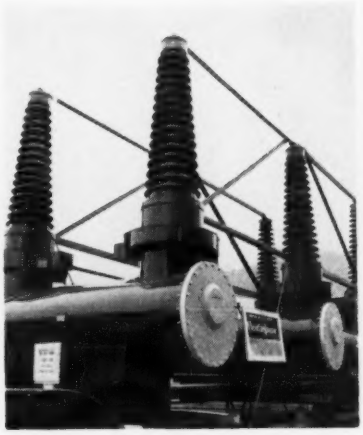
A recent application puts ultrasonics into the field of rat-chasing. Through history, poisons, traps and gases have been tried and worked well at first, but then bowed to the destruc-

Begins on page 146

tive rodent's shrewdness and agility. Ultrasonic sound-pressure dispersal may just be able to do the trick in ridding industrial buildings of varmints.

Rodent-dispersal machine broadcasts nerve-shattering high-frequency electrical impulses. They're unbearable to the rat but unheard by people and household pets. Sound-pressure waves are erratic, giving the rats no chance to build up immunity.

Since a current ratly census indicates these unwanted inhabitants outnumber people in the U.S., with a board bill running into the billions, the science of electronics may have supplied an important breakthrough.

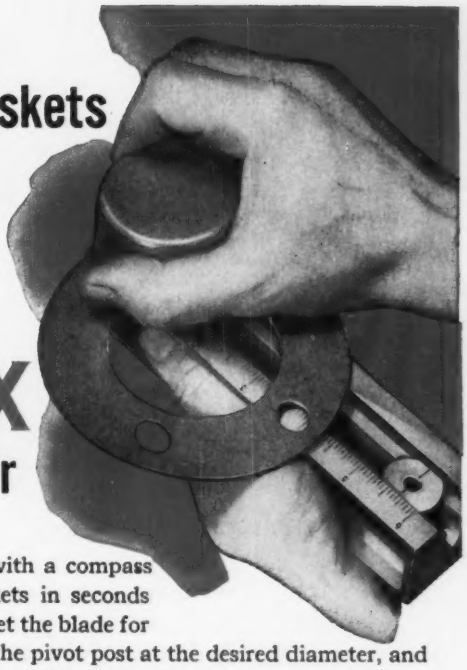


SF_6 breaker shipped with bushings in place

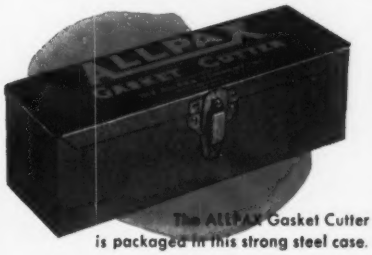
Westinghouse circuit breaker, above, was shipped fully assembled with bushings in place to its new home, Pennsylvania Power and Light Company's new Brunner Island Steam-Electric Generating Station on the Susquehanna River near Harrisburg, Pa. The 230-kv 15,000-mva unit uses SF_6 (sulfur hexafluoride) for interrupting medium. This is Westinghouse's first order for such equipment and the largest breaker they've ever shipped fully assembled.

At Brunner Island, Pennsylvania Power & Light mated the breaker with a conventional Westinghouse oil circuit breaker to protect 45 miles of 230-kv transmission circuits to its

Cut Perfect Gaskets *Easily* with the ALLPAX Gasket Cutter



If you can draw circles with a compass you can cut perfect gaskets in seconds with this handy kit. Just set the blade for the desired thickness, set the pivot post at the desired diameter, and a smooth swing of the cutter gives you a clean, accurate gasket . . . from a ¼ inch bolt hole to a 60 inch outside cut. Larger diameters can be cut with additional extension arms.



The ALLPAX Gasket Cutter is packaged in this strong steel case.

The ALLPAX Gasket Cutter has become standard equipment in thousands of plants where expensive "down time" is kept at a minimum by cutting new gaskets when and where they are needed. Available in five styles to cut maximum diameters of 12, 24, 36, 48, 60 inches.

Use the following Allpax gasket materials for your gasket requirements:

400—Compressed Asbestos Sheet
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Lay off that blow-off valve

You wouldn't hand fire your boilers, so why blow them that old fashioned way. The Madden System does the complete job automatically — controls solids concentration accurately; recovers practically all the BTU's from the blowdown water; yet requires no maintenance. If you can afford three square feet of space, you can afford the Madden Continuous Blowdown and Heat Recovery System; the savings will pay the initial cost within a year's time. Before you open another blow-off valve write for "Blowdown Low-Down". *The Madden Corporation, 1345 Jarvis Ave., Chicago 26, Ill.*

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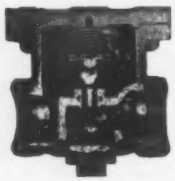
Sooner or later you too will be trapped by RIGGIO (why not now)

RIGGIO

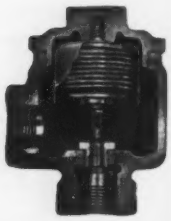
THERMOSTATIC STEAM TRAPS

pressures from Vacuum to 250 lbs.
Semi-steel Construction
½", ¾", 1", 1¼", 1½", 2"



TYPE B-250

pressures from Vacuum to 200 lbs.
Bronze Construction
½", ¾", 1"



TYPE A-200
Freeze-Proof

Simple
Rugged
Versatile
Tight Shut-off

For additional information contact

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Phone Webster 9-8450

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Powerscope

Begins on page 146

West Shore and South Akron substations. Installed in October, this is the first 230-kv SF_6 breaker to go into service, says Westinghouse.

Edison is enshrined in America's Hall of Fame

Thomas Alva Edison's first job was selling newspapers on the Grand Trunk Railroad. In 1931, at the age of 84, he died as one of America's most lauded inventors and scientists —he gave the world its first central electric-light power plant.

Best known as the inventor of the electric-light bulb which he developed in his early 30's, Edison had in earlier years produced a carbon telephone transmitter and the phonograph. A few years after his light-bulb discovery he built and operated an experimental electric railroad.

With his invention of the first commercially practical incandescent lamp, electric distribution for light and power including generators, motors, light sockets was well on its way. In 1881 the system was put to work in the Pearl Street plant in New York City.

The moving-picture industry is a prime beneficiary of Edison's genius —he was the first to demonstrate experimentally synchronization of moving pictures and sound. Talking pictures are based on his kinetoscope or peep-show machine.

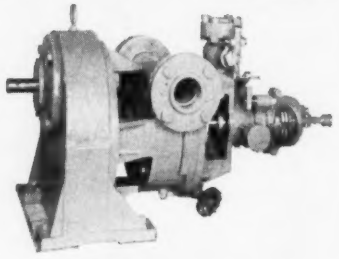
During World War I Edison helped develop U. S. manufacture of chemicals previously imported. Appointed head of U. S. Navy Consulting Board, he worked on ship defenses against torpedoes and mines. During his lifetime he had held over 1300 U. S. and foreign patents. He was a truly great American; his bust will be displayed at our national memorial, the Hall of Fame, at New York University.

Steel pump house sinks to river bottom

Cincinnati Gas & Electric Company engineers are planning an easy way to submerge their 3609-ton pump

CARLING

For 40 Years



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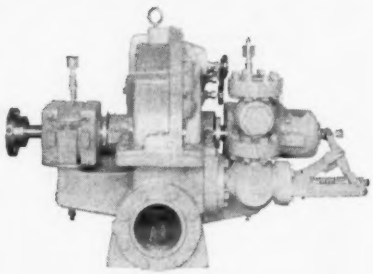
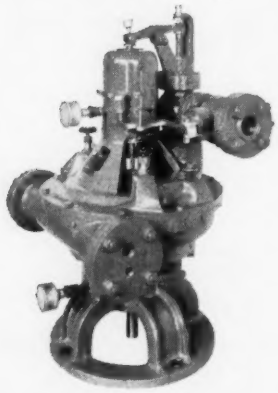


in TURBINES



WRITE FOR BULLETIN 20—C-3

CARLING TURBINE BLOWER CO.

7 NEBRASKA ST., WORCESTER, MASSACHUSETTS
Representatives in Principal Cities

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NEW

the multi-layer pipe insulation that goes on fast!

There's nothing dainty about new "K&M" Zebra. Its rugged, full body lets you work fast . . . almost forget about handling breakage. And once it's in place, this low, medium and high-temperature thermal insulation stands up to intense vibration—won't crack or warp from shock or heat . . . as proved in tests by K&M and independent testing laboratories.

Another Zebra advantage is this: it's made in half sections exclusively . . . even for the larger pipe sections. The result is speedier application with fewer joints. Zebra is also relatively lightweight . . . easy to cut and fabricate. It can be re-used . . . dismantled and re-applied. No skin abrasion or cuts either. Zebra has a smooth surface.

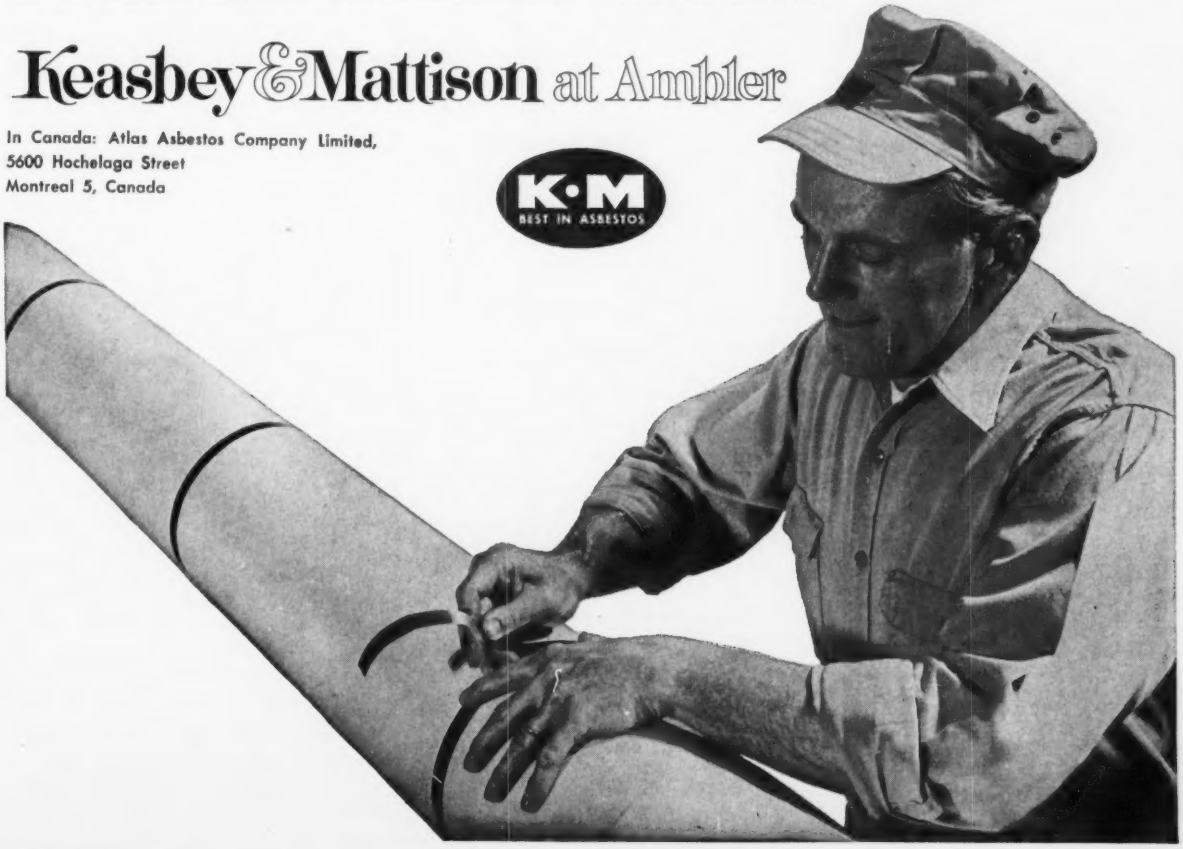
Write today for more information and a free sample of "K&M" Zebra—the rugged new pipe insulation that's fast to apply. Keasbey & Mattison Company, Ambler, Pa. Dept. I-121.

• for temperatures of 200° F to 1200° F • made of calcium silicate-asbestos fiber bonded felts • meets requirements for density, conductivity, modulus of rupture, and resistance to soaking heat • available in a wide range of sizes and thicknesses.

Keasbey & Mattison at Ambler

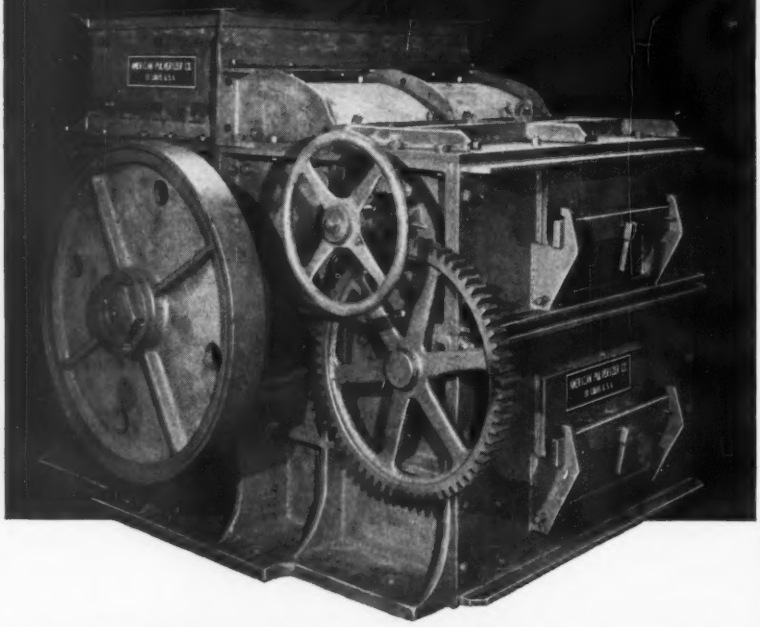
In Canada: Atlas Asbestos Company Limited,
5600 Hochelaga Street
Montreal 5, Canada

K·M
BEST IN ASBESTOS



For more facts circle 301 on Reader Service card, p 103

American Coal Crushers are RUGGED!



Soundly engineered and constructed to give you many years of high volume crushing at low operating costs.

1. Oversize bearings.
2. Alloy Steel heat treated rotor shaft.
3. Heavy rib reinforced housing with renewable liners and tramp metal pocket.
4. Manganese Steel crushing elements.
5. Exclusive American-Originated rolling shedder ring which splits coal instead of crushing it.
6. More efficient crushing design which permits slower operating speeds and less power consumption per ton of coal crushed.
7. Dual adjustment to give flexibility of size control and to compensate for wear.
8. Maximum flexibility of rolling ring rotor prevents injury from tramp iron.
9. Full width screening area gives faster discharge of reduced product.

Coal Crushers exclusively, from Sample Crushers to Capacities of 800 TPH
Write for literature stating capacity you need.

American PULVERIZER COMPANY
ORIGINATORS AND MANUFACTURERS OF RING CRUSHERS AND PULVERIZERS
1349 MACKLIND AVE. SAINT LOUIS 10, MISSOURI

house in the Ohio River. They're going to let the massive 59-ft steel construction sink by its own weight to bedrock through 30 ft of sand and ooze.

This "sand-island" method, usual for underwater-foundation construction — bridges, piers — is sometimes tried even on dry land. An artificial island of sand is formed by driving a circle of steel-sheet pilings into the river bed and filling it with sand. An 8½-ton steel ring with a cutting edge at the bottom is set on the sand. Concrete forms are then built on top of the ring and filled. When a section hardens, more is built on to increase the weight. As weight increases sand is dredged and structure starts sinking.

When completed this crib house will hold the big pumps supplying condensing water for Cincinnati Gas & Electric's new fifth and future sixth generating units. It will also be the foundation of a 515-ft stack. Stack and crib house with water-treatment equipment, pumps, screens, elevators and flyash-storage facilities is expected to cost over $1 million.

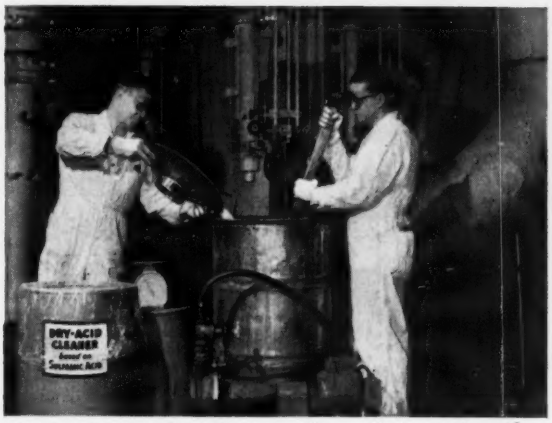
EEI and NEMA cosponsor Electrification Council

Starting last month Edison Electric Institute and National Electrical Manufacturers Association cosponsor Industrial Electrification Council to conduct educational-promotional activities in the industrial market. Electrical utilities and several individual electrical manufacturers have operated the Council since 1951.

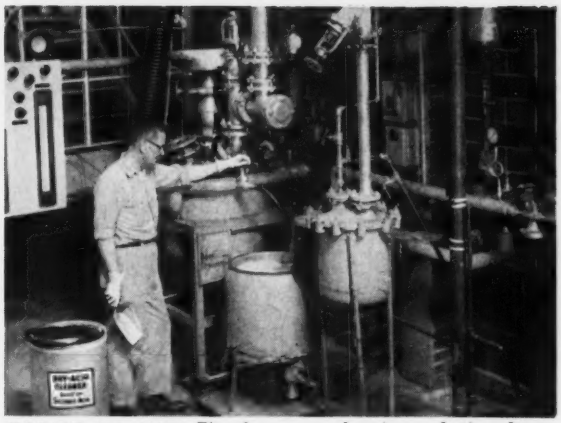
The Council was first concerned with promoting electric-heat use in industrial processes. It produced an application course for utility-company customers, held biennial industrial conferences. Success suggested broadening its scope by including factory electric-distribution systems.

First project under the new cosponsors: a course on plant distribution of electricity. Headquarters remain in offices of EEI, 750 Third Ave, New York, N. Y.

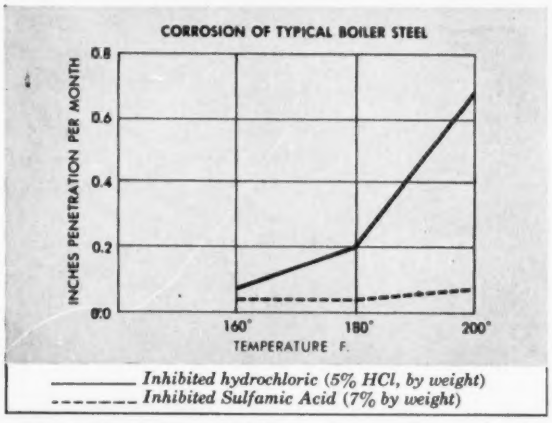
Descale boilers, heat exchangers, condensers rapidly, thoroughly with safer **dry acid** cleaners based on **Du Pont Sulfamic Acid**



SAFER TO HANDLE. Just pour dry acid cleaner based on Du Pont Sulfamic Acid from easy-to-handle, fiber drum into make-up tank. No danger from broken bottles, liquid spillage or corrosive fumes with these dry powders.



EASIER TO USE. Simply pump cleaning solution from make-up tank into boiler. Often dry acid cleaners can be added directly to equipment being cleaned. No elaborate equipment or specially trained labor needed.



LESS CORROSIVE. Sulfamic cleaners approach the strength of hydrochloric acid, yet are far less corrosive. Excellent inhibitor stability allows their use at higher temperatures for faster scale removal.

NON-FUMING. Sulfamic cleaners produce no corrosive fumes, either dry or in solution. Corrosion in vapor spaces of equipment during cleaning operation is eliminated, along with fume nuisance to personnel.

Ask your supplier for safer, effective cleaners based on Du Pont Sulfamic Acid, or mail coupon for additional information and names of formulators who offer these compounds.

E. I. du Pont de Nemours & Co. (Inc.)
Industrial & Biochemicals Dept., N-2539P
Wilmington 98, Delaware

Please send me ☐ sulfamic acid general equipment cleaning bulletin; ☐ names of formulators offering cleaners based on sulfamic acid.

*Name*_____

*Company*_____

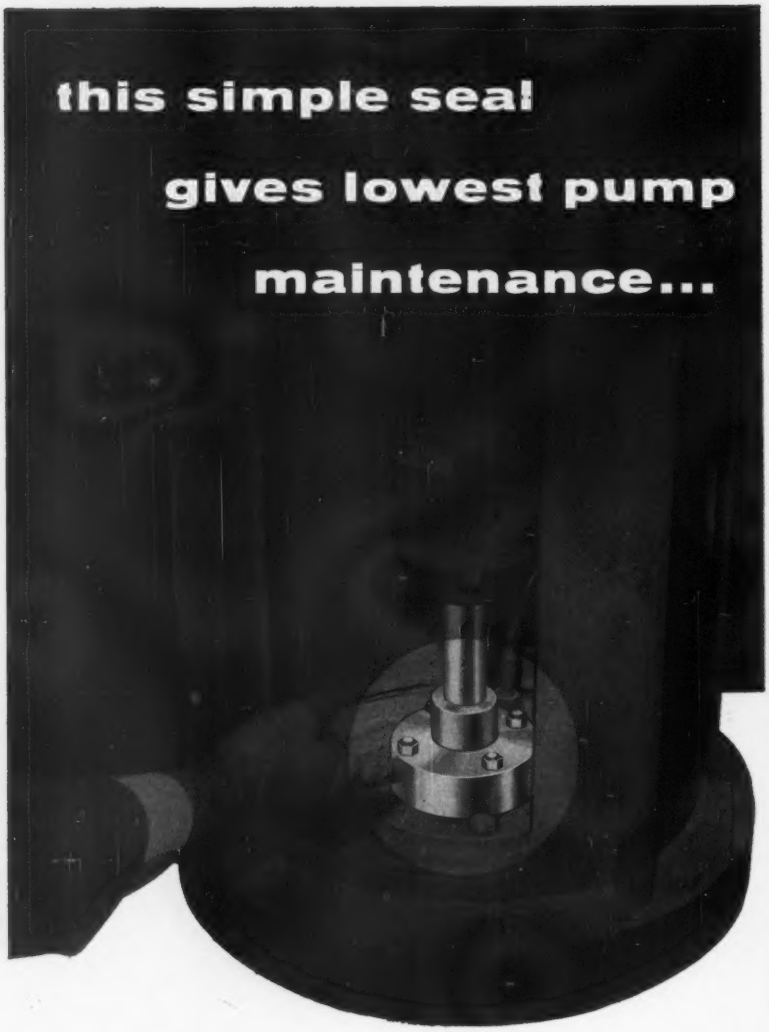
*Address*_____

*City*_____ *State*_____

DU PONT
REG. U. S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

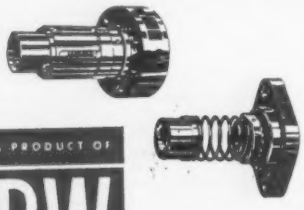
this simple seal gives lowest pump maintenance...



Save up to 66% of the time—expensive downtime—needed for installation or service of other mechanical seals used in plant process equipment.

The simple, effective Borg-Warner Type U Seal has no set screws—no close spring tension adjustments. It's fast and reliable.

For plants with a wide variety of pump service requirements, a minimum inventory of parts, and an easy change of gaskets adapts the Type U seal for service at temperatures of from —100 below zero to +650°F, and for pressures from 0 to 1000 psi.



Backed by Borg-Warner and proved in service, these dependable seals give complete safety, even in unattended stations.

Send for the latest Type U Seal engineering information —there's no obligation.

A PRODUCT OF B-W BORG-WARNER

Borg-Warner Mechanical Seals

P.O. Box 2017, Terminal Annex, Los Angeles 54, Calif.

For more facts circle 304 on Reader Service card, p 103

Calendar

Feb 26-March 2—Annual Meeting, Metallurgical Society, Society of Mining Engineers, Society of Petroleum Engineers—AIME, Ambassador and Chase-Park Plaza Hotels, St. Louis, Mo. Details: AIME, 29 W 39th St, New York 18, N. Y.

March 5-9—American Society of Mechanical Engineers, Gas Turbine Power Div, 6th Annual Gas Turbine Conference and Products Show, Shoreham Hotel, Washington, D.C. Details: C V Corbin, 20 Vesey St, New York 7, N. Y.

March 8-10—Instrument Society of America, 11th Annual Conference on Instrumentation for the Iron & Steel Industry, Roosevelt Hotel, Pittsburgh, Pa. Details: R R Webster, Jones & Laughlin Steel Corp, Research Lab, 900 Agnew Ave, Pittsburgh 30, Pa.

March 13-17—National Association of Corrosion Engineers, 17th Annual Conference and Show, Hotel Statler, Buffalo, N. Y. Details: T J Hull, 1061 M&M Building, Houston 2, Texas.

March 20-24—American Society for Metals, Western Metal Show, Pan Pacific Auditorium, Los Angeles, Calif. Details: J C Nelson, Metals Park, Novelty, Ohio.

March 21-23—American Society of Mechanical Engineers, American Power Conference, Sherman Hotel, Chicago, Ill. Details: ASME Meetings Dept, 29 W 39th St, New York 18, N. Y.

March 21-30—American Chemical Society, National Meeting, St. Louis, Mo. Details: R Avery, American Chemical Society, 2 Park Ave, New York 16, N. Y.

March 27-31 — National Symposium on Temperature—its Measurement and Control in Science and Industry, sponsored by American Institute of Physics, ISA, and National Bureau of Standards, Columbus, Ohio. Details: W R Tilley, NBS, Washington, D.C.

continued

Have you ever been troubled by any of these steam trap problems?

ARMSTRONG STEAM TRAPS are designed and made to eliminate these problems

BACK PRESSURE . . . Armstrong Traps operate on any back pressure—or vacuum, for that matter. As long as there is a pressure differential across the trap, it will close on steam and open for condensate. Even the high back pressure caused by blow through of one or more traps in the system will not disturb Armstrong Traps. Other than a reduction in capacity, Armstrong Traps are unaffected by back pressure.

DIRT . . . Armstrong Traps are not affected by ordinary dirt. When the trap opens condensate swirls down under the edge of the bucket and up through the discharge orifice. Dirt is kept in suspension and discharged along with the condensate. For very bad dirt conditions, Armstrong offers traps with integral strainers. These cost less than a trap plus a separate strainer.

AIR BINDING . . . Armstrong Traps cannot air bind. Air in the system passes through a vent in the top of the bucket. It collects in the top of the trap and is discharged with the condensate. There is no chance for it to stop the trap. For low pressure on-and-off units where large amounts of air accumulate while the steam is off, Armstrong offers open float and thermostatic air vent traps in a complete range of sizes.

WIRE DRAWING . . . Armstrong Traps are designed and made to resist wire drawing. The valve and seat are tough stainless steel. The valve opens and closes tightly with a fast action and is always water sealed. There is virtually no chance for grit or sediment to lodge in the valve, virtually no chance to create conditions that lead to wire drawing.

There's no need to accept any of these problems as "inevitable." Your local Armstrong Representative can show you how to end them all. Call him today or write direct.

860 Series for low pressure heating service.

800 Series, side inlet, side outlet.

No. 801, side inlet, bottom outlet.

880 Series, integral strainer.

200 Series, bottom inlet, top outlet.

Forged Steel Series for high pressures, high temperatures.

The 48 page Armstrong Steam Trap Book tells how to correctly size, install and maintain steam traps for any pressure, any temperature, any load plus full catalog data on Armstrong Steam Traps. Ask for Catalog K.

ARMSTRONG MACHINE WORKS

8124 Maple Street Three Rivers, Michigan

"See our Catalog in Sweet's Plant Engineering File"

For more facts circle 305 on Reader Service card, p 103

DRAFT SHORTAGES

LIMITING YOUR

GAS BOILER INPUTS?

END THOSE SHORTAGES WITH A DOUBLE-ACTING

FIELD DRAFT CONTROL*

*Field makes the draft assistance of the chimney available to the boiler for abundant draft at all firing rates, precisely controlled to the optimum twelve-to-one air-to-gas ratio recommended for clean, efficient combustion. Write for engineering data.

FIELD CONTROL DIVISION

Conco Engineering Works, Inc., Mendota, Illinois

AFFILIATES:

Spartan Tool Division — Powered Sewer Cleaning Equipment • Materials Handling Division — Cranes, Hoists • Conco Building Products, Inc. — Bricks, Tile, Stone

For 5"—34" Flues

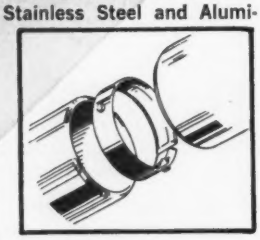
For more facts circle 306 on Reader Service card, p 103

ROBVON BACKING RINGS

FAST • PRECISE TOLERANCE FIT-UPS

Designed for quick easy alignment of pipe where the variation in inside diameters is relatively great. Chamfered NUBS allow close tolerance fit-up and CLEAN STRIKE OFF. The ROBVON NUB automatically sets root gap. ROBVON rings are beveled to assure non-restricted fluid flow. Available in Carbon Steel, Wrought Iron, Chrome Alloys, Stainless Steel and Aluminum.

TYPE "CCC"



Exclusive with Robvon

ROBVON BACKING RING CO.

Reg. Pat. Nos. 2,764,426 & 2,366,579 675 Garden St., Elizabeth 2, N. J., PH: EL 2-9613

For more facts circle 307 on Reader Service card, p 103

Calendar

Begins on page 156

March 27-31 — Instrument Society of America, 3rd Symposium on Temperature, Veteran's Memorial Hall, Deshler Hilton Hotel, Columbus, Ohio. Details: Meetings Dept, ISA, 313 Sixth Ave, Pittsburgh 22, Pa.

April 6-7—American Society of Mechanical Engineers, Management Engineering Conference, Statler-Hilton Hotel, New York, N. Y. Details: ASME Meetings Dept, 29 W 39th St, New York 18, N. Y.

April 9-13 — American Society of Mechanical Engineers, Oil & Gas Power Conference & Exhibit, Jung Hotel, New Orleans, La. Details: ASME Meetings Dept, 29 W 39th St, New York 18, N. Y.

April 10-11 — American Society of Mechanical Engineers, Maintenance & Plant Engineering Conference, Bancroft Hotel, Worcester, Mass. Details: ASME Meetings Dept, 29 W 39th St, New York 18, N. Y.

April 10-12—American Institute of Mining, Metallurgical and Petroleum Engineers, Open Hearth & Blast Furnace Conference, Sheraton Hotel, Philadelphia, Pa. Details: AIME, 29 W 39th St, New York 18, N. Y.

April 10-21—American Welding Society, 42nd Annual Convention and Welding Exposition, Sheraton-Atlantic Hotel, Coliseum, New York, N. Y. Details: Information Center, AWS, 33 W 39th St, New York 18, N. Y.

April 17-19—Instrument Society of America, 7th National Symposium on Instrumental Methods of Analysis, Shamrock-Hilton Hotel, Houston, Texas. Details: ISA, 313 Sixth Ave, Pittsburgh 22, Pa.

April 23-26—American Society of Mechanical Engineers, Metals Engineering Conference, Penn Sheraton Hotel, Pittsburgh, Pa. Details: ASME Meetings Dept, 29 W 39th St, New York 18, N. Y.

continued

NOW AVAILABLE IN "C" SIZE UNITS UP TO 75 H.P.

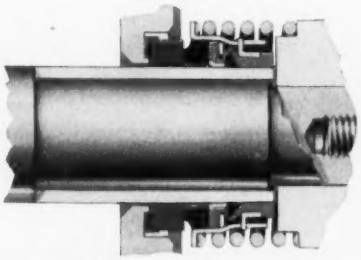
series 1510-B centrifugal pumps

HIGHER HEADS, GREATER FLOWS AT 1750 RPM!

Now, to its unequalled array of outstanding features, the B&G Series 1510-B Pump adds still another—*a broad range of ratings up to 75 HP*, with capacities to 2000 GPM, heads to 170 ft. and discharge sizes of 3″, 4″, 6″, 8″.

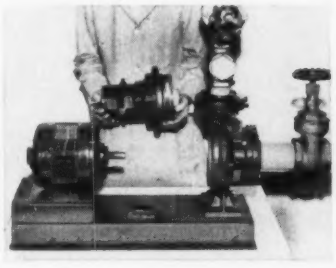
The series 1510-B is a vertical split-case pump designed for smoother, more efficient operation and longer life. Its balanced design enables the bearings to withstand loads far in excess of those developed by any pump and motor combination in the line.

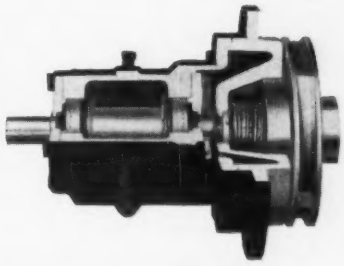
All parts are machined to rigid specifications, carefully inspected and accurately assembled, to insure minimum installation and maintenance expense. Exact uniformity of all parts means easy replacement in the field. All pumps are factory-tested for conditions of head and capacity specified.



LEAKPROOF "REMITE®" SEAL

This exclusive feature assures long, trouble-free life—eliminates the customary leakage which occurs when a packing gland is used. A Carbon Seal Ring faces on a "Remite" floating seat—*a new type of material so hard it will scratch glass—wear-proof and corrosion-resistant.* This Mechanical Seal is self-lubricating. A synthetic rubber bellows seals the shaft. Metal parts are of steel, bronze, or stainless steel, depending upon the type of service.





REMOVABLE BEARING FRAME MAKES SERVICING EASY

The photo shows how easily the complete bearing frame, including the seal and impeller, can be removed without disturbing piping or motor leads. The unit is replaceable and interchangeable in all pump sizes within limits of material construction.

Just five simple steps are required: 1. Loosen coupler set screws. 2. Slide coupler halves back on motor and pump shafts. 3. Remove center drop-out section. 4. Remove volute cover cap screws. 5. Lift out complete bearing frame assembly.

Among the features of the bearing assembly are anti-friction roller bearings to handle thrust and radial loads ...mechanically balanced impeller...oil lubrication.

STOCK PUMPS FOR QUICK SERVICE

Selected sizes of B&G Series 1510-B Centrifugal Pumps, as well as Series 1522 and 1531, are stocked at the factory for immediate shipment. Capacities to 225 GPM, heads to 140 ft. Send for Price and Selection Catalog.

BELL & GOSSETT COMPANY

Dept. GN-36, Morton Grove, Illinois

Canadian Licensee: S.A. Armstrong, Ltd., 1400 O'Connor Drive, Toronto 16, Ontario

END WATER LEVEL WORRIES

in those medium pressure boilers

Here's the great combination that takes all the worries and troubles out of water level and feed pump control for the many medium pressure boilers—boilers with steam pressures up to 150 psi.

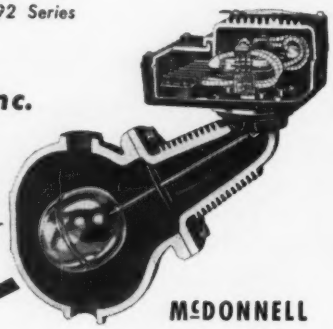
The drawing shows the simple hook-up. McDonnell No. 150 controls the boiler feed as it should be controlled—directly from the boiler water level. This holds the water level within the close limits that assure maximum steaming efficiency and fuel economy. Any deficiency in the returns is at once replaced by the McDonnell No. 27TA Make-up Water Feeder installed on the receiver.

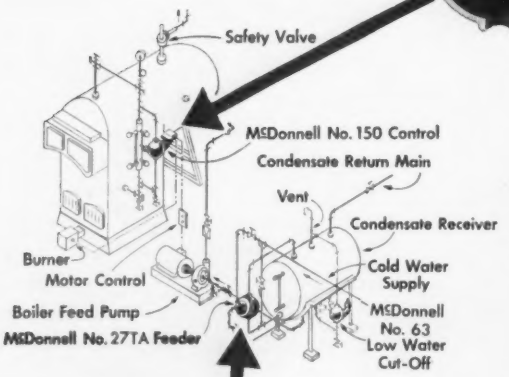
An extra switch on the No. 150 provides circuits for cutting off burner and sounding low water alarm—a final safeguard from emergency conditions such as current interruption in the pump circuit or failure of make-up supply.

Ask for engineering data covering all conditions. For boilers up to 250 psi. ask about the new 92 Series Pump Control.

McDONNELL & MILLER, *Inc.*
3506 N. Spaulding Ave.
Chicago 18, Ill.

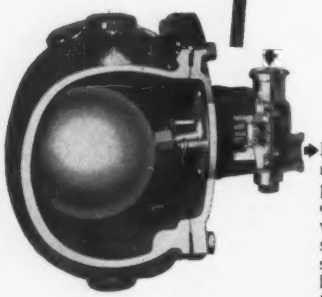
Doing One Thing Well





McDONNELL No. 150 PUMP CONTROL

The most widely used, time proved control of its type—for boilers up to 150 psi. Underwriters' Listed. Has two mercury switches—one for controlling feed pump and one for low water cut-off and alarm. Packless construction features heavy monel sylphon. Switch leads have porcelain bead insulation. Also available with water column type body—No. 157.



McDONNELL No. 27TA MAKE-UP WATER FEEDER

Has large water feeding capacity which permits locating the No. 27TA at a relatively low point on the receiving tank; this provides adequate space for return condensate, preventing wasteful overflow. Sturdy construction withstands turbulence in receiver. For tank pressures to 35 lbs., water supply pressures to 100 lbs. McDonnell Make-up Feeders also include flange-mounted types.

Your Jobber Stocks Them

McDONNELL
Boiler Water Level Controls

Boiler Water Feeders • Low Water Fuel Cut-Offs • Pump Controllers • Relief Valves
Flow Switches • Related Liquid Level Controls for Tanks, Stills, Air Conditioning Systems

Calendar

Begins on page 156

April 23-26—Oil Heat Institute of America, Inc, 39th Annual Meeting, Statler-Hilton Hotel, Wash, D.C. Details: OHI, 500 Fifth Ave, New York 36, N. Y.

April 26-27 — Metallurgical Society of AIME, National Technical Conference On H-T Materials, Pick-Carter Hotel, Cleveland, Ohio. Details: Metallurgical Society of AIME, 29 W 39th St, New York 18, N. Y.

April 30-May 3 — Electrochemical Society, Meeting, Claypool Hotel, Indianapolis, Ind. Details: Electrochemical Society, 1860 Broadway, New York 23, N. Y.

May 1-3 — Electric Association, Lighting Exposition, Lake Front Exposition Hall, Chicago, Ill. Details: Electric Association, 140 S Dearborn St, Chicago 3, Ill.

May 7-10 — American Institute of Chemical Engineers, Meeting, Sheraton-Cleveland Hotel, Cleveland, Ohio. Details: AIChE, 25 W 45th St, New York 36, N. Y.

May 7-11—American Society of Mechanical Engineers, Hydraulic Conference, Queen Elizabeth Hotel, Montreal, P.Q., Can. Details: ASME Meetings Dept, 29 W 39th St, New York 18, N. Y.

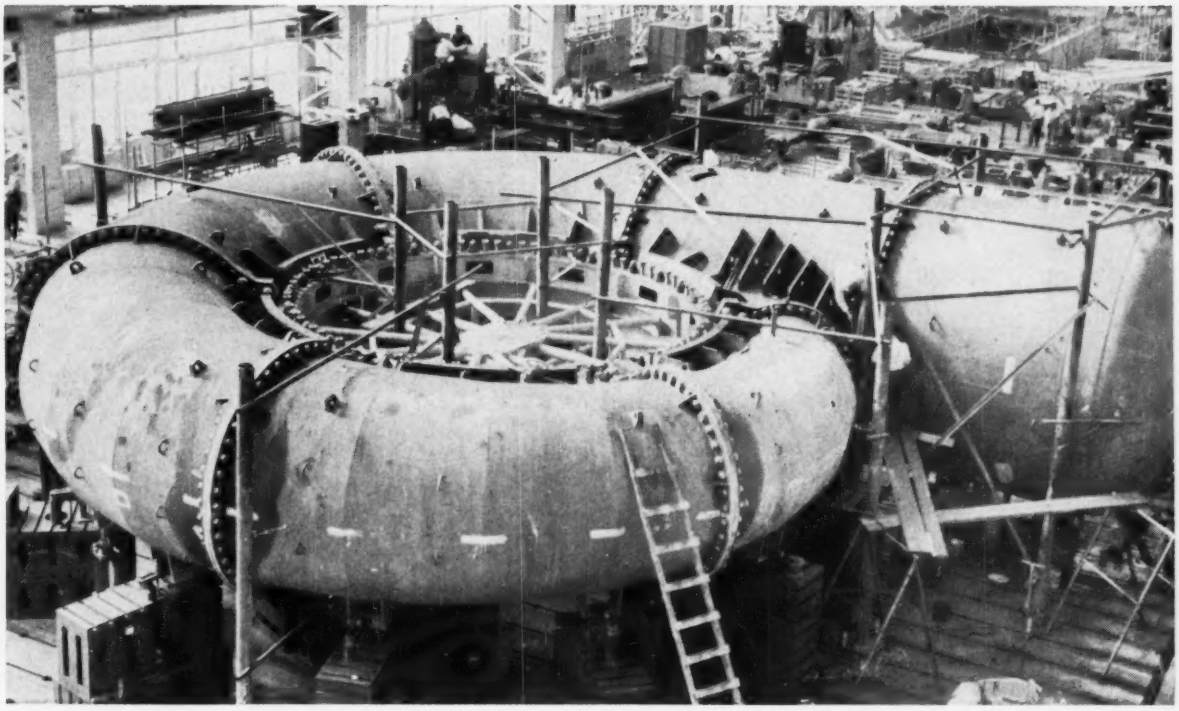
May 8-9 — American Society of Mechanical Engineers, Lubrication Symposium, Deauville Hotel, Miami Beach, Fla. Details: ASME Meetings Dept, 29 W 39th St, New York 18, N. Y.

May 9-11—Annual Western Joint Computer Conference, National Joint Computer Committee—Institute of Radio Engineers, American Institute of Electrical Engineers, Association for Computing Machinery—Ambassador Hotel, Los Angeles, Calif. Details: Dr W F Bauer, Thompson Ramo Wooldridge, Inc, Ramo-Wooldridge Div, 8433 Fallbrook Ave, Canoga Park, Calif.

continued

HITACHI

now completing the first hydraulic turbines for Thailand's Yanhee Project



Shop tests were recently completed on the spiral casing for the first of two 115,000 HP Francis-type turbines being completed by Hitachi for Thailand's Royal Irrigation Department. These will be the first of the planned 8 sets of generating units to be installed at the downstream of the Bhumiphol Dam, as part of the Yanhee Multipurpose Project which will commence operation in 1963 and eventually supply 560,000 kW of power to Bangkok and Thonburi. The vertical shaft Francis turbines have been designed to deliver 115,000 HP under the effective head of 112 m and for a speed of 150 rpm. Their spiral casings, with inlet diameter of 4150mm, will each be divided into 7 sections for transportation by barge up the Ping River to the site.

Hitachi, Ltd.
Tokyo · Japan

Cable Address: "HITACHY" TOKYO

For more facts circle 310 on Reader Service card, p 103

Will your main steam line VALVE PACKING take . . .

Chesterton '1000'

1. Will not shrink.
2. Will not harden.
3. Will not cause electrolytic action.
4. Will not burn-out.

CHESTERTON Style 1000 solves this toughest of all Packing conditions by a completely new departure from past high pressure Steam Packing manufacturing practices.

Style 1000 is made of an Inconel reinforced super-quality, extremely long fiber asbestos braided into a tight heat and pressure resistant Packing which contains no graphite to cause electrolysis nor soft lubricating oils to boil out and create shrinkage.

Style 1000 contains no hardening agents nor rubber cement. It is lubricated with a special Mica base compound which will not boil out or cause pitting action.

CHESTERTON 1000 is ideal for all high temperature, high pressure steam valves and is without equal as a Soot Blower Packing.

We highly recommend your ordering a trial box today. CHESTERTON distributors are located in all major industrial areas. Write for free sample and name of your local distributor.

PACKING Chesterton SERVICE

A. W. CHESTERTON CO.
America's Oldest Manufacturer of Mechanical Packings
7 Ashland St., Everett 49, Mass.

Calendar

Begins on page 156

May 8-10 — Instrument Society of America, 4th National Power Instrumentation Symposium, LaSalle Hotel, Chicago, Ill. Details: Meetings Manager, ISA, 313 Sixth Ave, Pittsburgh 22, Pa.

May 10-12—Pulp and Paper Instrumentation Symposium, sponsored by ISA, TAPPI, Northland Hotel, Green Bay, Wis. Details: Meetings Services Dept, ISA, 313 Sixth Ave, Pittsburgh 22, Pa.

May 22-24—10th National Telemetering Conference, sponsored by ISA, AIEE, ARS, IAS, IRE, Chicago, Ill. Details: Meetings Services Dept, ISA, 313 Sixth Ave, Pittsburgh 22, Pa.

May 22-25 — American Society of Mechanical Engineers, Design Engineering Conference & Show, Cobo Hall Hotel, Detroit, Mich. Details: ASME Meetings Dept, 29 W 39th St, New York 18, N. Y.

June 5-8—Instrument Society of America, Summer Instrument-Automation Conference and Exhibit, Royal York Hotel, Queen Elizabeth Hall, Toronto, Ont., Can. Details: W H Kushnick, ISA, 313 Sixth Ave, Pittsburgh 22, Pa.

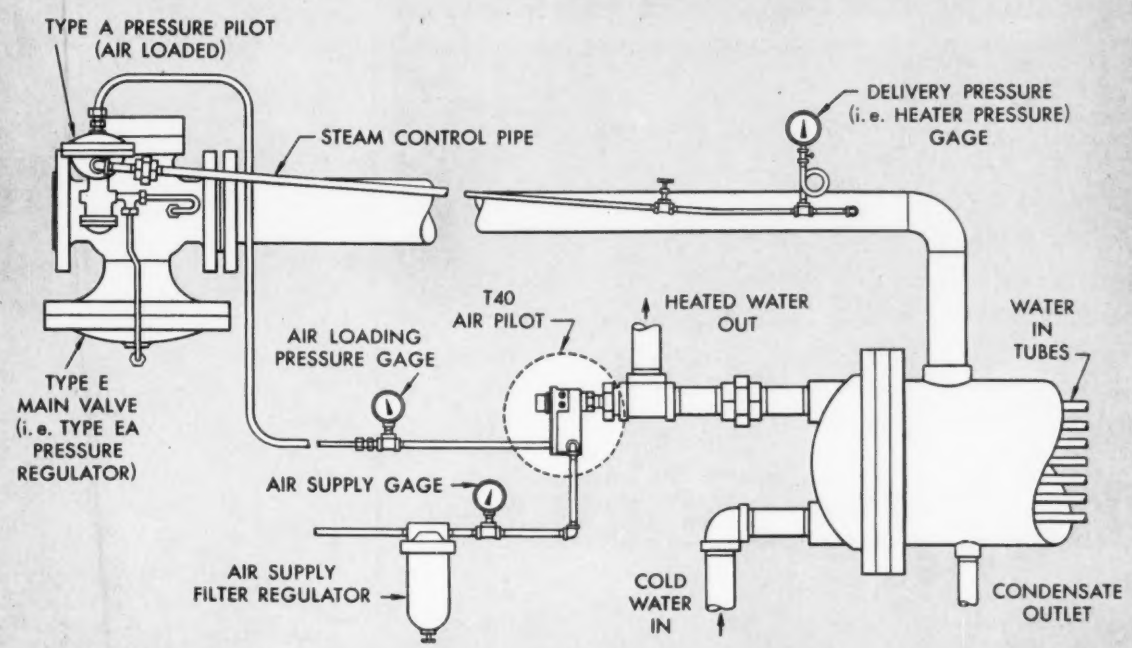
June 11-15 — American Society of Mechanical Engineers, Summer Annual Meeting, Statler-Hilton Hotel, Los Angeles, Calif. Details: ASME Meetings Dept, 29 W 39th St, New York 18, N. Y.

June 12—Air Pollution Instrumentation Symposium, ISA, APCA sponsoring, Hotel Commodore, New York, N. Y. Details: Meetings Manager, ISA, 313 Sixth Ave, Pittsburgh 22, Pa.

June 12-15 — National District Heating Association, 52nd Annual Meeting, Wentworth - by - the - Sea, Portsmouth, N. H. Details: J F Collins Jr, NDHA, 827 N Euclid Ave, Pittsburgh 6, Pa.

For more facts circle 311 on Reader Service card, p 103

New Spence Temperature Control System Gives Unusual Control Accuracy



TYPE EAT40 AIR-CONTROL TEMPERATURE REGULATOR (Patent Pending)

In a recent installation the new Spence air-control temperature regulating system provided:

- ±5°F control accuracy under wide and instantaneous load swings of 210 to 80 gallons per minute.
- Up to 50% reduction in cost as compared to instrument systems of similar accuracy.

This unique cascade-type control with throttling range adjustment independent of maximum heater pressure was developed to meet today's demand for greater control accuracy.

Additional features of the new Spence Temperature Control System include:

- 200°F wide adjustable temperature range
- Adjustable speed of steam pressure change
- Over and under temperature protection
- Pressure limit control
- Fast response
- Very low air consumption
- Field reversible for heating or cooling

The Spence Type EAT Air Control Temperature System, when properly installed, will tame wide ranging, fast changing loads of instantaneous heaters and modern heat exchangers. The cascade principle plus the use of an extremely fast responding bi-metal temperature sensing element reduce time lags and provide control stability.

Here's how the new Spence system operates:

Quick response is based on a bi-metal temperature sensing element. Temperature pilot continuously regulates a loading air pressure.

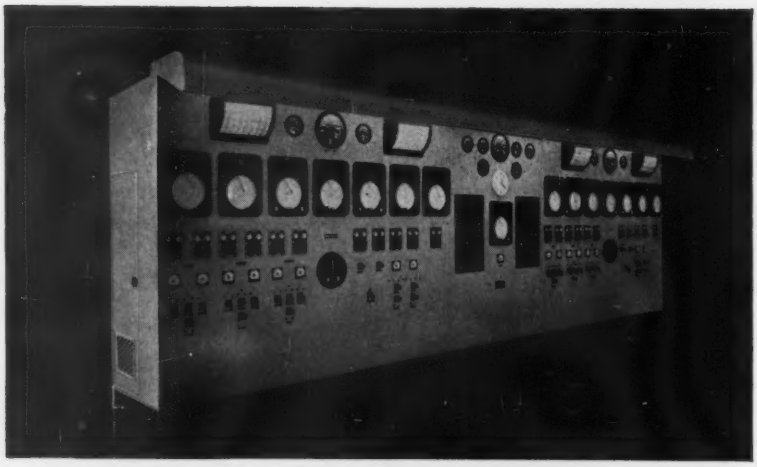
This loading signal, when applied to a pressure regulator to reflect heater temperatures, causes it to adjust the main valve as changes in load require.

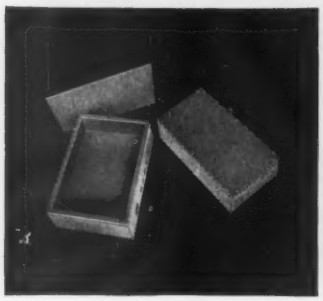
Spence has also developed a new pressure control system based on this same cascade principle. This system has a control accuracy of ½ psi or better from positive pressures through the vacuum range to 30" Hg.

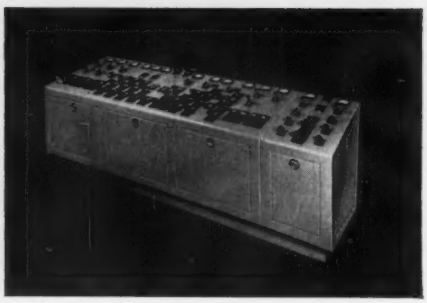
For complete information on these new air controlled temperature and pressure control systems, write for your copy of Bulletin 9.

SPENCE ENGINEERING COMPANY, INC.
Walden, New York
SE-140

For more facts circle 312 on Reader Service card, p 103

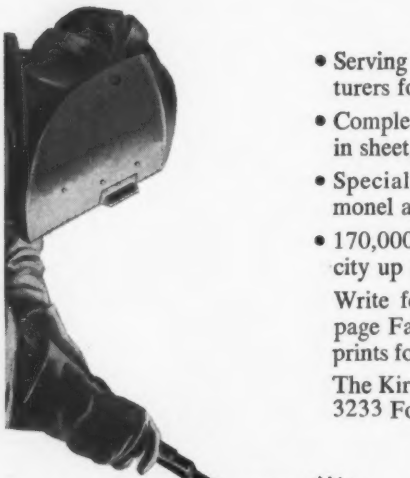






Sheet Metal and Alloy Components, Weldments and Plate Work, Custom Fabricated

Electrical Enclosures



- Serving the nation's leading manufacturers for over 50 years
- Complete facilities to ½" thicknesses in sheet, plate and light structurals
- Specialists in stainless, aluminum, monel and other alloys
- 170,000 sq. ft. plant with crane capacity up to 25 tons

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KIRK & BLUM

Appointments

Purchases & mergers

Federal Pacific Electric Co: acquisition of Pioneer Electric Ltd of Canada. **Franklyn Engineering Corp:** wholly owned subsidiary of Burns and Roe, Inc merged with interests of Col C B F Brill to be known as Brill Engineering Corp. **The Louis Allis Co:** purchase of the Dynapar Corp. **Riley Stoker Corp:** acquisition of all capital stock of Union Iron Works.

EJC elects

James N Landis

Bechtel Corp vice-president James Landis was elected president of Engineers Joint Council at a meeting of the Council's board of directors in Nov. A past-president and council member of ASME, Landis succeeds Augustus B Kinzel, vice-president of Union Carbide Corp, who headed EJC for the past year.

EJC is a national federation of 21 engineering societies. It was organized to advance national and human welfare by promoting cooperation among the various specialties of engineering. Vice-president of the organization is George Holbrook, last year's vice-president. Holbrook, a past-president of AIChE, is vice-president of E I du Pont de Nemours & Co.

Landis graduated from the University of Michigan in 1922 with a BS in mechanical engineering and

For more facts circle 313 on Reader Service card, p 103

joined Brooklyn Edison Co in 1923. Since then he has served as head of contract control and inspection and assistant mechanical engineer for Consolidated Edison Co and chief power engineer in charge of engineering design and layout of steam-power plants for Bechtel. He became vice-president in 1953.

Awards

C E Lesher, consultant, formerly with the Pittsburgh Coal Co and president of its subsidiary, Pittsburgh Coal Carbonization Co, the Percy Nicholls Award by Coal Div of AIME and Fuels Div of ASME.

J F Lincoln, board chairman of The Lincoln Electric Co, James H McGraw Award, Manufacturers Medal by NEMA.

N J MacDonald, president of The Thomas & Betts Co, the James H McGraw Award Medal for Co-operation by NEMA.

E Morss, president of Simplex Wire & Cable Co, the James H McGraw Award Manufacturers Medal by NEMA.

T E Millsop, president and chief executive officer of National Steel Corp, the Benjamin F Fairless Award for 1961 by AIME.

Consultant change

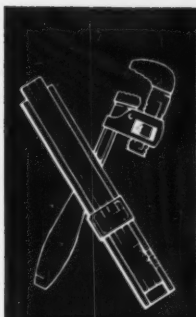
J A Millard has entered private practice as a hospital consulting engineer. His new office is at 2201 Britt Ave, Lima, Ohio.

Obituary

Jerome Bartels, Professor of Mechanical Engineering at Polytechnic Institute of Brooklyn for 12 years and an author of articles on thermodynamics, died at the age of 47.

Aside from teaching, he worked in the Turbo-Generator Div of General Electric from 1957 to 1959.

Professor Bartels was a partner in the consulting firm of Peterson & Bartels from 1948 to 1951 and also worked for six years in the Engineering Design Office of the New York Naval Shipyard in Brooklyn.



YOU GET EVERYTHING THE ENGINEER & MAINTENANCE MAN ASKED FOR IN THIS NEW LIGHT WEIGHT, COMBINATION STEAM TRAP!

Fast warm up through rapid removal of both air and condensate up to 10° F. of saturation.

•

Continued discharge of air and condensate at steam temperature.

•

Built-in filtration of solids

•

Easy access to all working parts

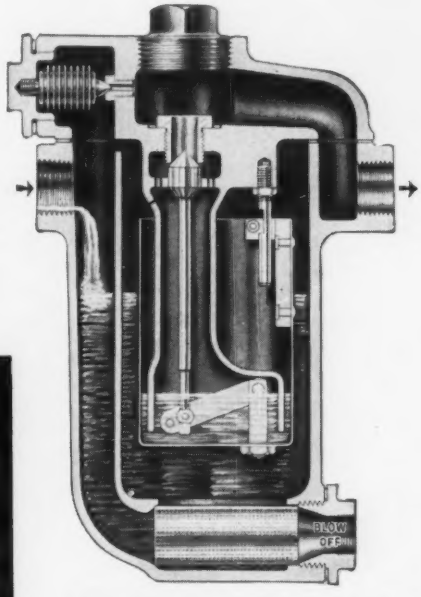
•

Interchangeable main orifice

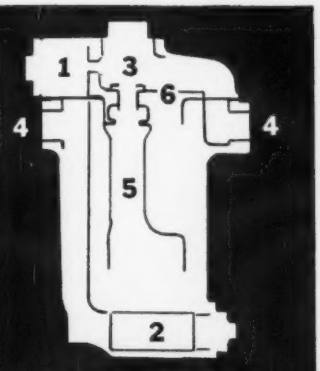
•

Light enough to be supported by line

Step by step steam traps have been improved, making them compact, lighter and more efficient, easier and faster to service. Now Wright-Austin has incorporated all these advances into one of their proven vertical bucket-type traps—the new 500-C series. Write for literature.



500-C Series—For ½" to 2" pipe lines; Pressures to 150 PSIG; Capacity to 30,000 lbs./hr.



1. Monel thermostat air by-pass
2. Monel strainer
3. Valve seat accessible through inspection plug
4. Straight-through pipe connections
5. All operating parts stainless steel
6. Working parts removed with cover

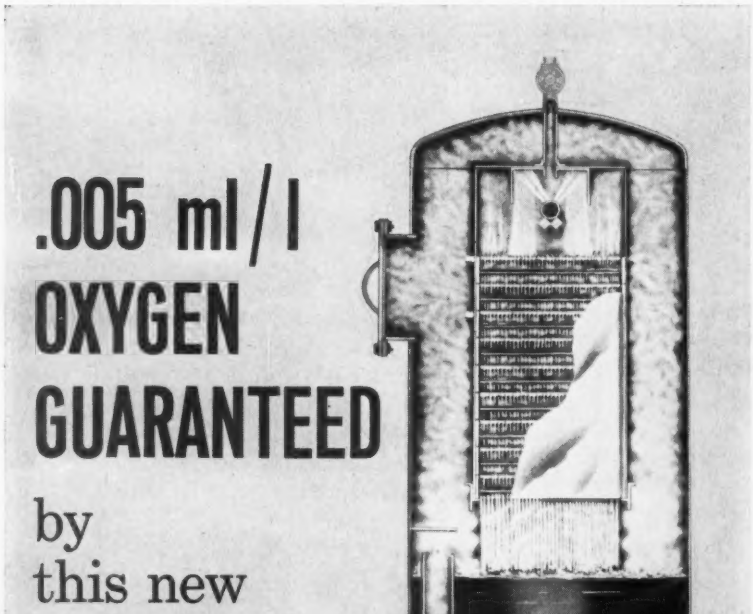
For fast and continuous heat in:

Unit heaters
Hot water heaters
Steam mains
Laundry equipment
Platen presses
Heat exchangers
Cylinder dryers
Jacketed Kettles
Sterilizers
Evaporators

WA 1894 **WRIGHT-AUSTIN COMPANY**
3245 WIGHT STREET • DETROIT 7, MICH.

For more facts circle 314 on Reader Service card, p 103

FLUIDICS* AT WORK



The picture above illustrates the new Permutit Tray Deaerator, which is *guaranteed* to reduce oxygen to .005 ml/l, or less, and to remove all the free CO_2.

This sectioned illustration shows the stainless steel trays and inner chamber. Steam passes upward through them, while the water spills down from tier to tier, constantly being exposed to the steam until, fully deaerated, it reaches the reservoir at the bottom.

The highest temperature incoming steam contacts this final deaerated water. It is also the purest, oxygen-free steam, and as it sweeps upward it takes to the vent all the freed corrosive gases.

The highly efficient internal vent condenser saves B.T.U.'s by reducing vented steam to a negligible wisp which is just enough to carry off all the non-condensable gases.

Guaranteed Water

These and the other design aspects of the Permutit Tray Deaerator enable us to give you a *guarantee* that you'll always get feedwater with (a) less than .005 ml of oxygen per liter of water, and (b) no titratable free CO_2.

And just off the presses is our Bulletin 4732, containing information on the construction details, operation, and other advantages of the Permutit Tray Deaerator. Send for a copy.

Permutit Division, Dept. PO-21, 50 West 44th Street, New York 36, N. Y. In Canada, The Permutit Company of Canada, Ltd., 207 Queen's Quay West, Toronto 1, Ontario.

*FLUIDICS is the Pfaudler Permutit program that integrates knowledge, equipment and experience in solving problems involving fluids.

PFAUDLER PERMUTIT INC.
Specialists in FLUIDICS . . . the science of fluid processes

Engineers'

Advanced Mechanics Of Fluids. *By D W Appel, P G Hubbard, L Landweber, E M Laursen, J S McNown, H Rouse, T T Siao, A Toch and C S Yih. Edited by H Rouse, State University of Iowa. 444 pp, illust, tables, cloth, $9.75. John Wiley & Sons, Inc, 440 Fourth Ave, New York 16, N. Y.*

This advanced text builds on Rouse's earlier, more-basic book, *Elementary Mechanics of Fluids.* Assuming the reader's firm grounding in advanced calculus, book covers these topics: (1) research in fluid motion (2) fundamental concepts and equations (3) principles of irrotational flow (4) conformal representation of 2-dimensional flow (5) laminar motion (6) turbulence (7) boundary layers (8) free-turbulence shear flow. The book closes with a list of answers to problems given throughout the text.

Concepts of Thermodynamics. *By E F Obert, Professor of Mechanical Engineering, University of Wis. 528 pp, illust, cloth, $11.00. McGraw-Hill Book Co, Inc, 330 W 42nd St, New York 36, N. Y.*

Modern approach to engineering thermodynamics emphasizes the fundamentals of calculus and gives a physical significance to each function that underlies the symbol for a concept. This approach makes apparent the independent variables for differential equations of thermodynamics.

Book aims mainly to give a sound but simple mathematical structure with precise definitions and derivations. A rather complete section on calculus is included in Appendix A. A survey of methods for solving thermodynamic equations in Chapter 11 emphasizes definitions, bases derivations on the fundamental definitions of the differentials.

Physical definitions are given for functions of heat, work and the mass elements for both closed and open systems. The ideas of temperature, entropy, fugacity, friction, availability and chemical equilibrium are reviewed. Equations of continuity, energy and momentum for nonsteady flow are derived. This book is for the serious student of thermodynamics—it has a large number of problems and many illustrative examples.

For more facts circle 315 on Reader Service card, p 103

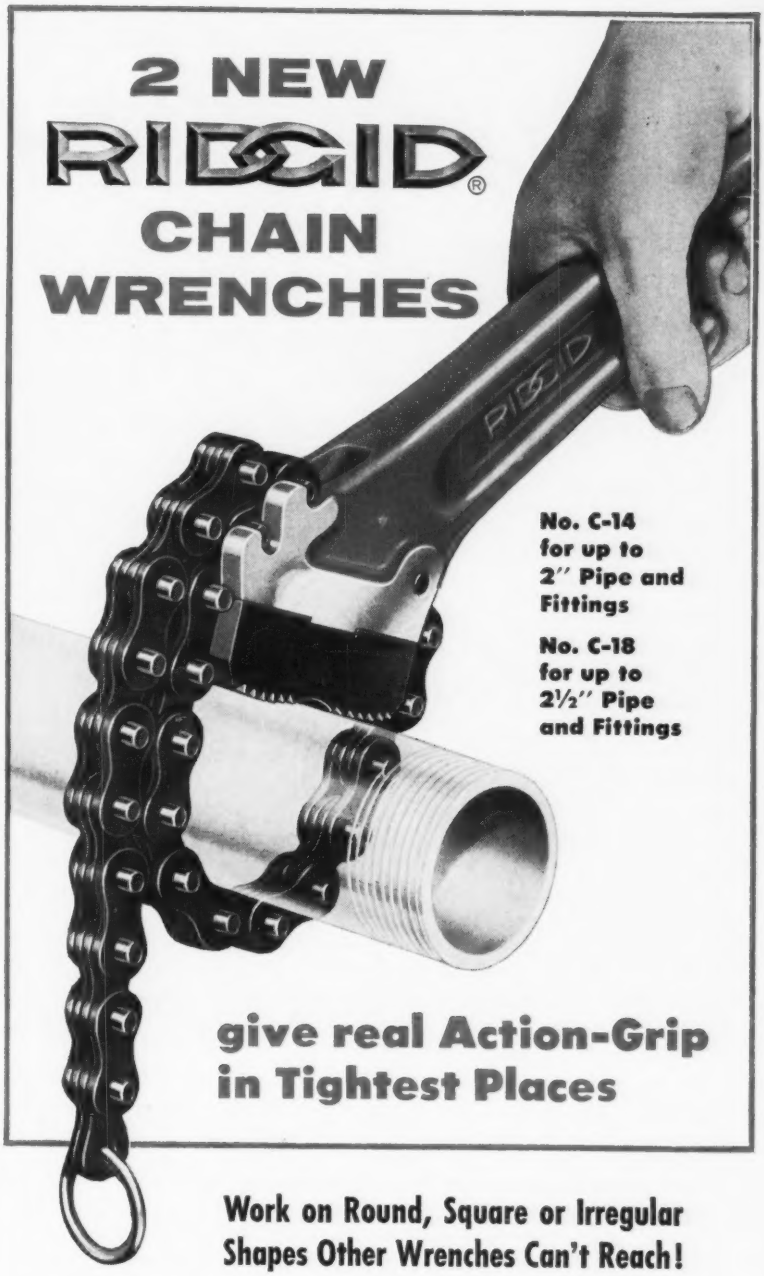
bookshelf

Electrical Engineering Fundamentals. *By J P Neal, Dept of Electrical Engineering, University of Ill. 402 pp, illust, cloth, $8.50. McGraw-Hill Book Co, 330 W 42nd St, New York 36, N. Y.*
Subtitled "A unified introduction to electrical engineering," this book presupposes college physics courses in mechanics, electricity and magnetism and math courses in analytic geometry, algebra and calculus. Engineering interpretations of the physical characteristics and laws of electromagnetic systems are presented in terms of the rationalized mks system of measures (limitations as well as scope of mks measures are discussed).

Book reviews essentials of elementary vector mathematics. Relations between elementary field theory and elementary network theory are illustrated by deriving equivalent electric and magnetic network elements for simple physical devices. Fundamental engineering concepts are presented in terms of appropriate mathematics.

Electromechanical Energy Conversion. *By D C White, Professor of Electrical Engineering and H H Woodson, Assistant Professor of Electrical Engineering, Mass. Inst of Technology. 646 pp, illust, tables, $12.50. John Wiley & Sons, Inc, 440 Fourth Ave, New York 16, N. Y.*
First the book establishes the fundamentals of analytical dynamics to lead to an understanding of interactions in an electromechanical system. With these, typical energy converters can be analyzed. Analyzing several simple transducers illustrates the essential concepts of the conversion method. Emphasized: a thorough treatment of dynamic characteristics of energy converters, feedback-control-system theory and their interrelations.

A 2-phase model of an electric machine classified as the generalized machine is developed, its equations of motion derived and used for all machine analyses in later chapters. Technique of applying constraints to general dynamic equations is used in a detailed treatment of the dynamics of commutator, induction and synchronous machines.



Work on Round, Square or Irregular Shapes Other Wrenches Can't Reach!

In extra close quarters, there's nothing that'll beat these new RIDGID Chain Wrenches for getting the job done. Fast, ratchet-like action in either direction . . . from either side. Give tight grip without crushing. Large, easy-to-grab end ring for fast chain adjustment. Tempered steel chain locks securely . . . releases quickly. Rugged, comfort-grip, I-beam handle, guaranteed not to break or warp . . . handy hang-up hole.

Light and easy to use, these new RIDGID Chain Wrenches do everything a regular wrench can do . . . and much more. Call your Supply House and get one today!

RIDGID
The Ridge Tool Company, Elyria, Ohio, U.S.A.

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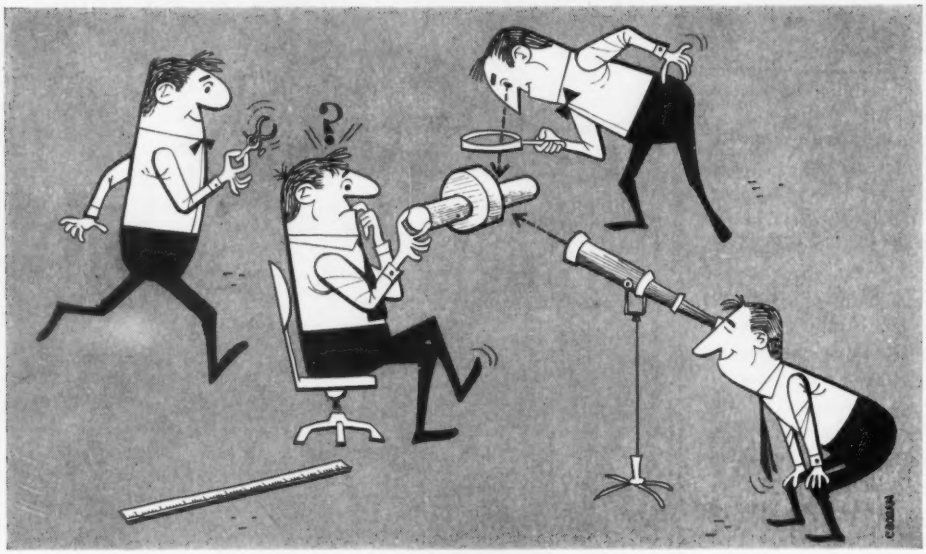


George Edwards

suggests: Look at what you read

A friend of ours, supervisor of electrical and mechanical instruction for a large utility, recently was compiling information for his men to prepare them for stationary-engineer license exams. One question frequently asked by examiners: "What is the throw of an eccentric?" Our friend checked a number of reference books. All but one agreed that the throw of an eccentric is the radius of the circle described by the eccentric center.

He was understandably surprised by the dissenting book, which states that "throw" is "equal to the diameter of the circle described by the center of the eccentric, and not the radius as ignorantly defined by the greenhorns and other nondescripts."

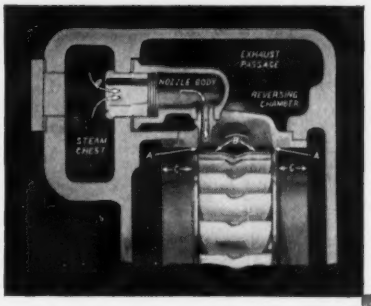
I'm not making a case for or against anyone's definition of anything. But the situation points up a curious characteristic, common to a great many people; a willingness to believe, often without question, practically anything they see in print. They may not be willing to accept a statement that reaches their brains via their ears, because, consciously or unconsciously, they're aware that a fellow human being is making these sounds with his mouth and—well, you know how it is—it isn't necessarily true just because this guy says so. But if this same guy puts his statement in print—whether it's just a mimeographed sheet, a pamphlet, a book, or, the apparently absolute form, printed in a newspaper—then it becomes gospel. It matters not whether the newspaper is the twice-monthly *Hog-Jowl Gazette* published in Fallen Arch, U.S.A. or a great metropolitan daily, it is fact because "the newspaper says. . . ."

Aside from generally recognized proponents of yellow journalism there's no question that today's newspapers bend every effort to reporting the facts. However, much depends on the source from which the "facts" are obtained. Much depends on whether that source is interested in the public learning that the glass is "half full" or "half empty." And the newspaper sincerely believes that it is publishing exactly what the situation is.

Truth often is that, as journalists say, the source has "slanted" the story for public consumption. Perhaps some half-truths, a few veiled insinuations, an inference or two—and it adds up to something that would take a lengthy investigation to unravel. In the cleverly worded account there often are generalizations and assumptions that insult the intelligence of a reader who takes time and trouble to analyze the wording. But enough people have to care enough to challenge it, and the source banks on most readers accepting it because it's in print.

It would be somewhat ridiculous to imply that a technical-book author would deliberately "slant" his text in an attempt to color a reader's thinking. But authors can make mistakes in ignorance—as evinced by the difference in definitions of eccentric throw. Such statements are quickly challenged by those who know better. But how about the guy who —wanting to learn—puts blind faith in what he sees in print?

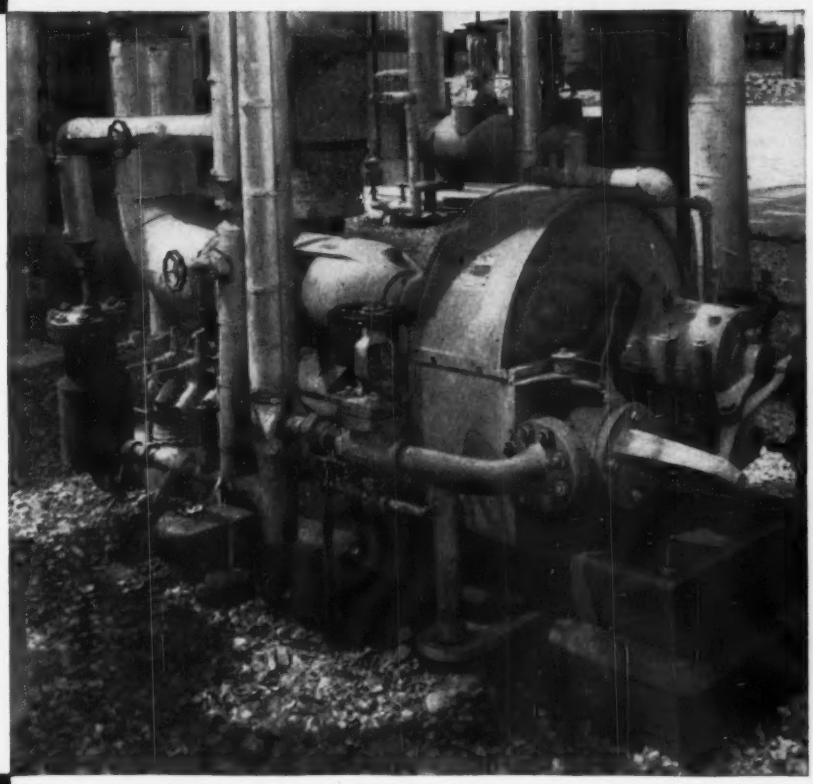
Unfortunately, whether deliberate distortion or honest ignorance causes the printed word to be something less than factual, the end result is the same. The reader, prone to believe what he sees, casts his mental die. And correcting faulty dies can be a mighty expensive process.



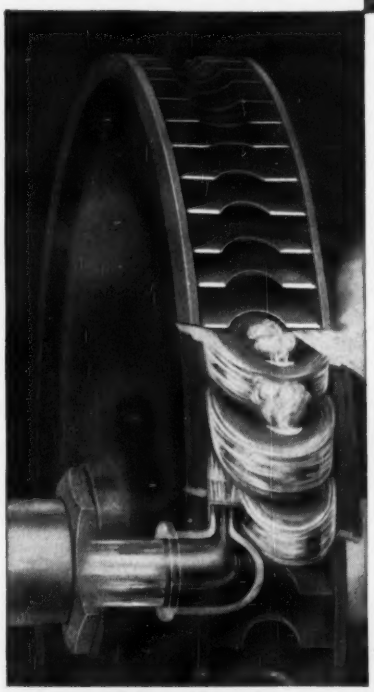
TWO REASONS WHY

this turbine seldom sees down time

1 ***Generous wheel clearances:*** AA —rim clearance, B—blade clearance, CC —side clearance. Blades can't foul as they are protected by rims. Rubbing at AA will do no damage. Side clearance is so large (about one inch) that end-play from excessive external thrust cannot damage wheel.



2 ***Blade wear is of little consequence.*** In a Terry solid-wheel turbine, the steam enters the buckets at right angles to the shaft. As its power-producing action takes place on the curved surfaces at the backs of the buckets, wear does not materially affect horsepower or efficiency.



To prevent costly shutdowns for repairs, Terry builds bonus reliability into each solid-wheel turbine. Two of the ways in which this is accomplished are shown in the diagrams at the left.

Further details of these simple, fool-proof turbines are illustrated and described in bulletin S-116. If you do not already have a copy of this publication, send for one today. No cost or obligation.

THE TERRY STEAM TURBINE CO.
TERRY SQUARE, HARTFORD 1, CONN.

TT-1217

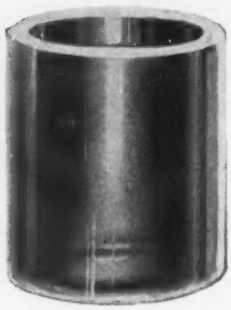
TERRY

For more facts circle 317 on Reader Service card, p 103

CORNING INDUSTRIAL GLASSWARE FOR EVERY JOB

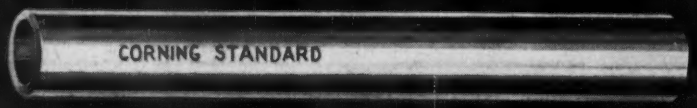
Name your problem, and there's a Corning Industrial Glass Product to fit it. They're stocked locally, too, by most industrial distributors and mill supply houses. Carefully engineered, they are designed to withstand temperature change, mechanical shock, corrosion, and every hazard they'll be exposed to. You've a wide selection, too. Sight glasses, for example. They're made for temperatures up to 500°F, pressures up to 300 psi. But don't wait for emergencies to threaten production, create unnecessary down time. Stock up with replacements now . . . at least *three* for each installation. Then you'll be sure.

Lubrication inspection



PYREX® Lube Glasses

Up to 100 psi



Corning® Standard Gauge Glasses

Extra visibility

PYREX® Red-Line Gauge Glasses

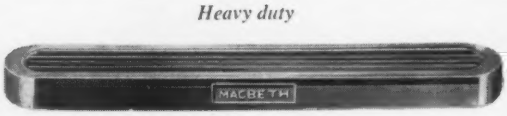
Higher pressures

PYREX® Heavy-Wall Gauge Glasses

Higher temperatures

PYREX® High-Pressure Gauge Glasses

Heavy duty



Macbeth® Flat Glasses

Furnaces, reactors, pressure vessels

PYREX® Sight Glasses

Visible discharge

PYREX® Oil Cup Glasses

CORNING GLASS WORKS

CORNING MEANS RESEARCH IN GLASS

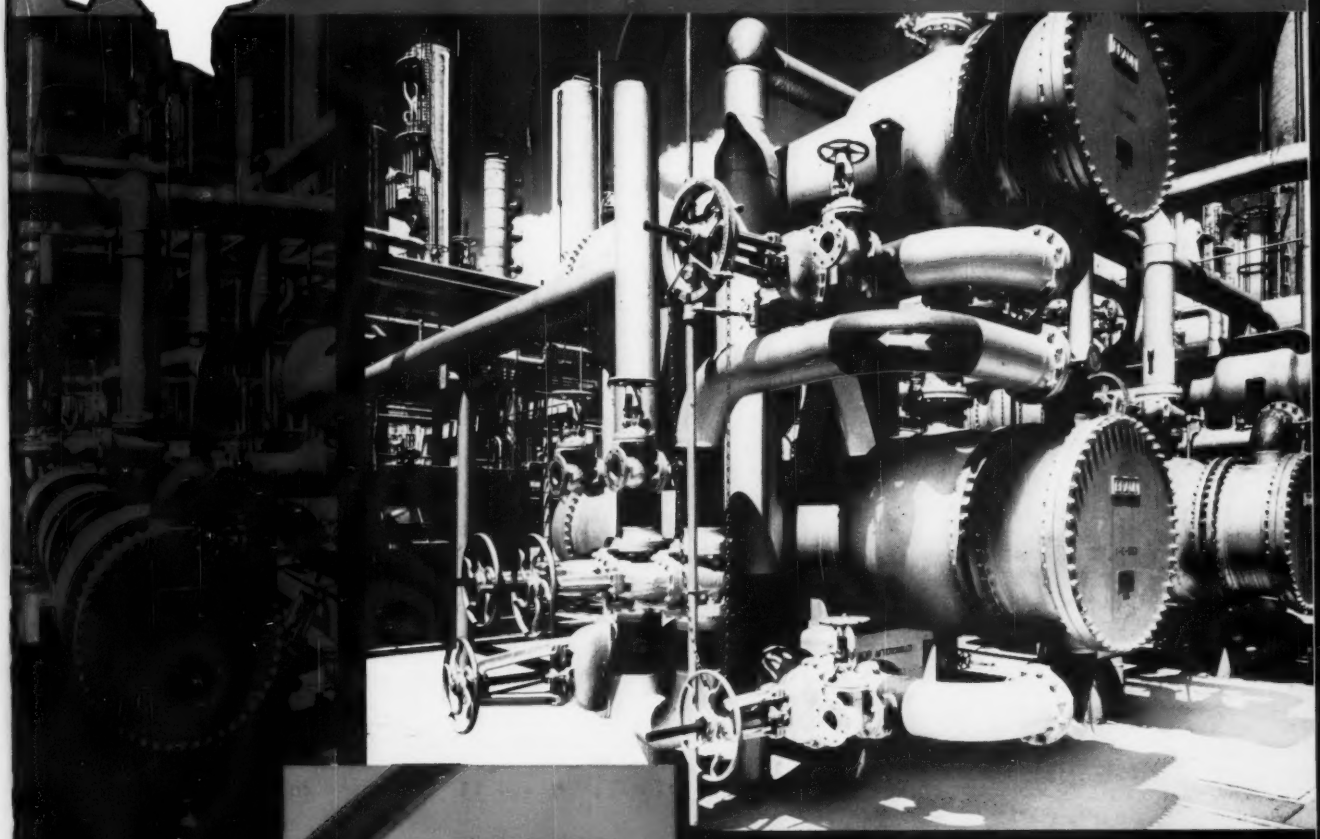
For more facts circle 318 on Reader Service card, p 103

For more facts circle 319 on Reader Service card, p 103 >

Petro-Tex®

where trouble-free performance is a matter of pride...

CHEMICAL CORPORATION • HOUSTON, TEXAS



SCOVILL®

HEAT EXCHANGER TUBE for Applications from Marine to Petrochemical, from Compressor Intercoolers to "Cat-Cracker" Exchangers, in these popular Alloys . . . Phosphorized Admiralty • Admiralty • Arsenical Admiralty • Red Brass, 85% • Deoxidized Copper • Arsenical Copper • Copro-Nickel, 10%-20%-30% • Aluminum Brass • Aluminum Bronze, 5% • Muntz Metal • Duplex Tube

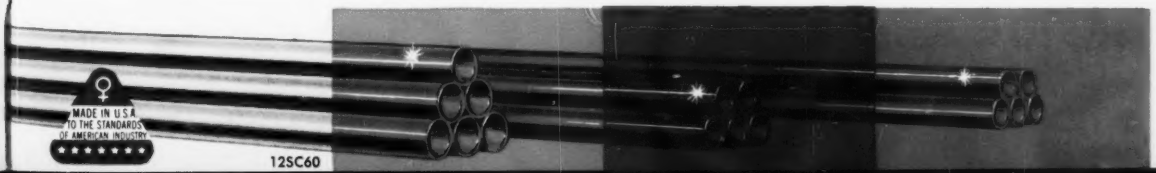
HEAT EXCHANGER TUBE

As in so many other modern chemical and petro-chemical processing plants, these typical heat exchanger units at the Houston Plant of Petro-Tex Chemical Corporation are tubed with Scovill PHOSPHORIZED (Inhibited) ADMIRALTY Heat Exchanger Tube. This alloy has often been specified by operating engineers for assured trouble-free performance under conditions where dezincification has been a problem and because of its excellent resistance to the effects of sulphur compounds, acid or contaminated fresh or salt waters. The range of permissible conditions for using this alloy is quite wide.

Similarly, Scovill's eleven other popular heat exchanger tube alloys have been formulated to meet specific service needs. Scovill Technical Service with an exceptional background of experience in this special field can help you select the alloy best suited to assure trouble-free performance in your installation.

SCOVILL MANUFACTURING COMPANY

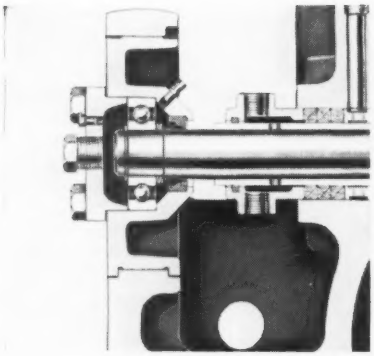
Mill Products Division, 99 Mill Street, Waterbury, Connecticut. Phone PLaza 4-1171



12SC60

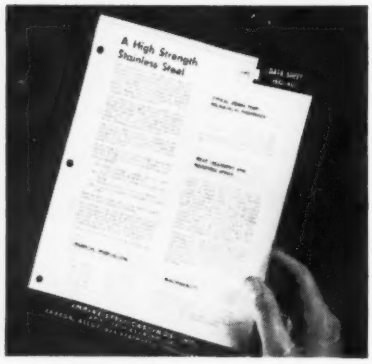
PUMPAGE

Goulds news about pumps for process industries



When life hangs by 5/1000 of an inch

Whether life is long or short depends on the proper fit of shaft to bearing. Destroy the fit by 5 to 10 thousandths of an inch—and you shorten bearing life. Therefore Goulds pump shafts are ground and polished to within the tolerances specified by bearing manufacturers. To insure complete accuracy, bearing housings are bored by a special machine. Careful handling when removing and replacing bearings in the field will also go a long way toward protecting fit and helping bearings live to a ripe old age.



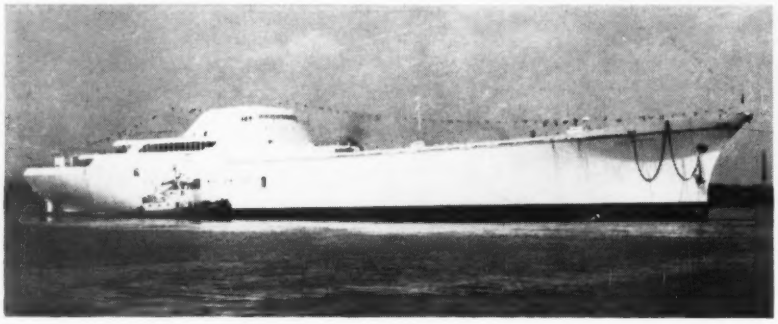
Now... ISO-40 to guard against corrosion and abrasion

A stainless of great strength, ISO-40* alloy survives under some very harsh conditions. Strongly oxidizing nitric solutions don't faze it. It's a match for 50% sulfuric at r.t. It resists corrosion, abrasion, high shock. Can be furnished with a B.H.N. hardness of 320, tensile strength of 145,000 psi. A pump with an ISO-40 impeller circulated a slurry of sodium sulfite and sodium carbonate for 17 months with negligible impeller damage. Speaking of pumps, did you know you can get Goulds chemical pumps in ISO-40?

*Registered trademark of Empire Steel Castings, Inc.

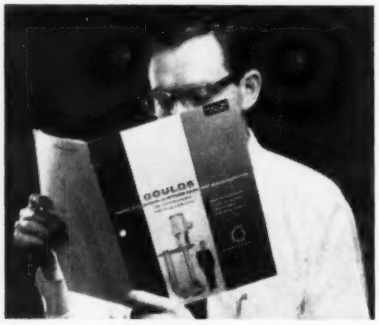
Circulating crude phthalic anhydride

One company does it with two Goulds Model 3171's. Each delivers forty gallons a minute of this sluggish solid (sp. gr. 1.2) from a depth of 11 ft. at temperatures from 300 to 525 F. How? The discharge pipe, which extends from pump through pit cover, wears a steam jacket. Temperature stays up—phthalic anhydride stays fluid. The long pipe has a 3″ expansion joint. Additional steam-jacketed pumps of other and varying lengths give flexibility to the installation. For details on how Goulds Model 3171's can help *you* move uncooperative solids, write for Bulletin 726.2.



Nuclear nomad of the seven seas

N. S. Savannah, first atomic-powered merchantman, will call at the seaports of the world as a symbol of the peaceful use of nuclear power. The 21,800-ton ship has a practically foolproof power plant. Its pressurized-water nuclear reactor uses uranium oxide fuel. Goulds Model 3655 (close-coupled centrifugal) pumps the radioactive waste water on both bilge and ballast service. The Model 3655 is available in 23 sizes with capacities to 2000 gpm, heads to 400 ft. Pump and motor are a single, compact unit, easy to install and ready to run. Standardization of parts holds down inventories. For full details, including specifications, construction information and performance charts, write for Bulletin 710.1.



NEW "king-size" vertical... capacities to 3180 gpm

Here are all the details on Goulds newest heavy-duty centrifugal sump and process pump—the "L" size Model 3171. Unit available in 316 stainless and other special alloys. Specifications, sectional views, construction materials, performance curves, dimensions—all are clearly given in Bulletin 726.2. For your copy, write Goulds Pumps, Inc., Dept. PO-21, Seneca Falls, N. Y.

GOULDS PUMPS

For more facts circle 320 on Reader Service card, p 103

STEVE ELONKA
Associate Editor in Charge

MASTERMINDING cost-cutting program here is Emerson Consultants' Senior Vice-President Charles Sloane and time-study engineer Tom Foster. One program saved client $600,000 a year

Can smart consultants slash your high maintenance costs?

By STEVE ELONKA, Associate Editor

"How is it possible," I asked, "that an outside management consultant can step into a modern industrial plant and slash their maintenance bill by $600,000 in one year? It seems like an enormous saving—yet that's precisely what your case history indicates." The scene was an office high in Manhattan's Radio City, and I was talking with Charles Sloane, Senior Vice-President of Emerson Consultants, Inc. Sloane reflected a moment, then leaned back and replied in his clear, deliberate way:

"There are several excellent reasons, Steve. Here they are:

"First, we have time to make a thorough investigation as basis for an objective report. Many company officials are too busy to make such a study. And if they do take the time, they can't always be as objective as an outsider might.

"Second, we work with basic industrial principles set down 50 years ago by our founder, Harrington Emerson, in his book, *The Twelve Principles of Efficiency*. These have stood the test of time and usually spotlight major faults in industrial organization or administration at the very start of our study.

continued

Case histories show where an outside consultant can help

"Third, our objectivity about personalities often lets us fit people into jobs they might not otherwise have been considered for. This can bring about a large saving because people work so much better when they like the work they're doing.

"Fourth, we gather and analyze our own facts, base our objective decisions on facts we collect rather than on people's opinions. We talk with employees at all levels to learn the true feeling between employees and management. That often helps us spot a basic fault the 'inside men' may have overlooked.

"There are many more reasons," smiled Sloane, "but we can sum them up. Of course, your management engineer must be competent—whether he comes from inside the plant or outside. But an outsider starts with three advantages. He has more independence of thought and action, an objective approach to problems, freedom from company traditions—and traditional prejudices.

"For these reasons he can state 'bad-medicine' facts and conclusions based on those facts as an employee could not do without—in some cases—risking his job security. The expert's counsel has been requested and is being paid for, so when he comes up with a proposal he gets attention and quicker action than an employee of the client can. His specialized experience may show him ways to improve management and control of the maintenance group where people in the client's organization can't see the overall problem objectively."

Sloane went on to present his case in the form of some interesting clinical details:

Case history No. 1: A metals-manufacturing plant employed thousands of people. After a preventive-maintenance system was started, firm reduced emergency maintenance orders from 95% of the total to 5%. Production went up 21%, maintenance costs came down 20% of previous figures—all within a period of two years.

Case history No. 2: A small industrial chemical plant had 300 people on their maintenance payroll. Consultant helped them reduce their maintenance costs through better control and administration by some 10%. Four years later a check showed their maintenance, measured as a ratio between actual maintenance costs and $ of plant investment, down 38% in the four years. Here the client not only took the original advice, but went much further in following up the principles established four years before.

The maintenance people not only lowered their costs, but also greatly improved the condition of plant equipment. Among the causes for continuing gains was better training of supervisors. Clerical work formerly done by the supervisors was placed in the planning dept where it belonged. Revised, simplified paperwork gave supervisors more time to watch quantity and quality of work turned out. Last not but least, consultant managed to pass on a bit of inspiration to keep top maintenance management pushing and driving.

Case history No. 3: A refinery had a maintenance scheduling problem. Consultant started a work-measurement system using refinery's own people. A few years later, when other changes went into effect, the firm said their maintenance savings were averaging $600,000 a year. And following through on planning and scheduling of maintenance kept costs on the downward trend. They had been able to concentrate their maintenance work on the day shift, eliminating expensive and unpopular night work. This accounted for a big chunk of the savings.

Everyone wants to measure maintenance before and after changes are made, but this isn't always easy to do. Over the years, Sloane's firm has developed a "maintenance audit" for measuring effectiveness of maintenance and setting up successful controls. The actual audit contains some 250 questions to be answered and rated, but this is the general idea:

Maintenance audit not only measures performance on a before-and-after basis, but, more importantly, shows direction of major opportunities for improvement.

(1) Organization control brings together the human resources, molds them into a smoothly functioning team.

(2) Planning control deals with the work-planning aspect of maintenance—how well the unit is handling its planning, scheduling and allocation of manpower.

(3) Purchasing and stores control measures the working relationship for buying needed materials, parts and supplies. It also indicates presence or absence of inventory management and inventory-control techniques.

(4) Departmental-relationship control includes responsibilities and activities of nonmaintenance departments which (a) influence the activities of the maintenance department (b) affect the working climate (c) establish limiting conditions (d) either assist or restrict maintenance management in providing most-efficient service.

(5) Preventive-maintenance control finds the best-available preventive-maintenance procedures and the degree to which they're being applied.

(6) Engineering control looks into basic engineering-dept responsibilities in relation to maintenance, shows how well they are carried out to provide the greatest combined contribution of these two services.

(7) Cost control checks to be sure suitable controls and methods are used. These provide the means of recording maintenance costs and trends.

(8) Work-load control governs the maintenance load and methods of execution. It indicates how well backlog and work requests of other departments are handled. It identifies the built-in obstacles of the present system.

(9) Productivity control deals with measuring produc-

tion, shows whether present control system is complete.

"Plenty of time must be taken to train personnel in the new methods we initiate, human nature being what it is," Sloane told me. "Just handing the client instructions to follow seldom gets results. It's not easy to make people change their habits. There is more human engineering than any other type in our consulting work. Once people *want* to follow recommendations, they usually also want to improve on them. That means continual gain for the client and that's what we both want."

To wind up the interview, Charles Sloane had a surprising story to tell: "If we can help a company save $250,000 a year on maintenance at a cost of $70,000 or $80,000 in consultants' fees, it would seem to be a good bargain. But oddly enough this isn't always their view."

"Recently I was talking with a fellow who owns a paper plant. When I suggested that we would like to take a look at his operation to see if we could save him money, he just wasn't interested. He said that as sole owner his income was in the 90% tax bracket. So if we saved $100,000 out of the firm's operations, he would have to fork 90% back to Uncle Sam. It wasn't worth the trouble to him.

"I don't need to tell you that's a highly short-sighted view. Some day competition is going to catch up with that man. As profits dwindle, his 90% tax bracket won't mean much, and he'll be lucky if some management firm can pull him out of the hole he's dug."

With today's maintenance costs often spelling the difference between red and black ink, I'm sure POWER readers will find Sloane's ideas thought-provoking.

MAINTENANCE CHECK LIST

Organization	✓
Force Report	✓
Assigned Men	Ok
Supervisory Ratio	Yes
Average Wage	✓
Incentives	✓
Equipment Records	Ok
Work Orders	Ok
Preventive Maintenance	✓
Prefabs	✓
Backlog Report	Yes
Priorities	✓
Peak Loads	✓
No. of Orders	Ok
Overtime	✓
Planning & Scheduling	✓
Time Estimates	✓
Craft Sequence	Ok
Major Repairs — Turnarounds	Ok
Coord. of Shop & Field	✓
Construction	✓
Inspection	✓
Stores Turnover	✓
Transportation	Ok
Craft Jurisdiction	✓
Emergency %	✓
Automotive Units	Yes

CHECK LIST of 27 points makes sure no factor has been overlooked. Consultant's objectivity gets program started fast

Field man follows this plan to set up a maintenance program

(1) Spend a few days in plant making preliminary inspection
  (a) Uncover faults of organization
  (b) Check procedure for handling work orders
  (c) Check clerical work the foreman does
  (e) Estimate money to be saved by better methods
  (f) Estimate number of management consultants needed to work out a program

(2) Write proposal based on above. Aim: persuade management to retain consultant

(3) Make engineering report (takes up to three weeks to get all facts) to sell management

(4) Work out overall program
  (a) What is being done at present
  (b) What ought to be done
  (c) How to get it done

(5) Discuss with management and supervisors. Show how ideal picture will work

(6) Develop procedures needed to put accepted changes into effect

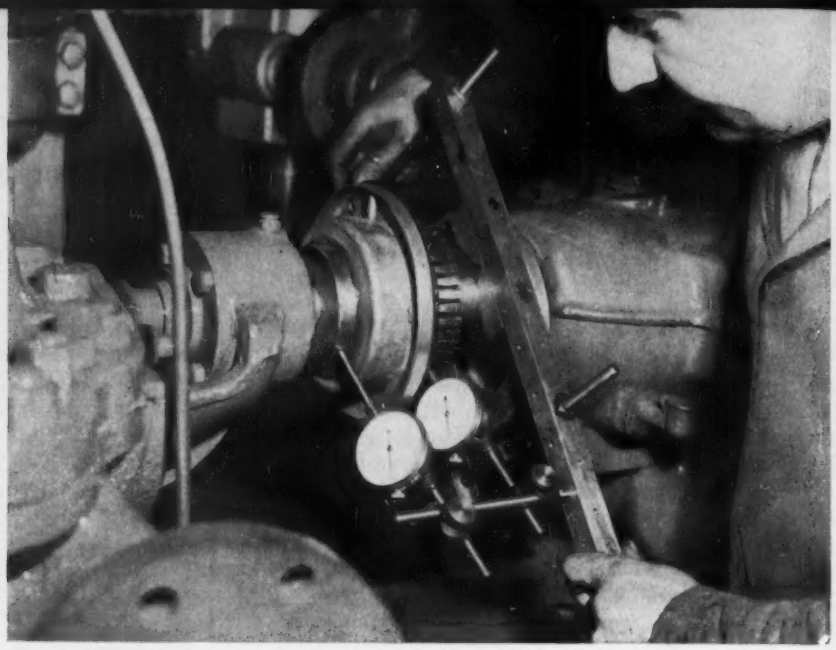
(7) Install procedure, get people to change habits
  (a) Planning and scheduling

(8) Stay on job until new system works smoothly and all key personnel are fully trained

Chemical-company score sheet records big savings in eight months

Subject control	November survey, %	July survey, %	Gain, % points	Gain, %
Organization	70.8	84.3	13.5	19
Planning	46.8	74.5	27.7	60
Purchasing & stores	67.0	68.5	1.5	2.24
Departmental relationships	75.5	86.0	10.5	14.0
Preventive maintenance	33.0	48.5	15.5	47.0
Engineering	44.0	56.0	12.0	27.0
Cost	43.0	66.0	23.0	53.5
Productivity	19.0	61.5	52.5	275.0
Work load	64.0	79.0	15.0	23.5
Combined score	51.6%	69.6%	18.0	35.0%

PERCENTAGES above are based on the maintenance-measurement audit, with each of nine categories weighted to add up to 100%



PROPER ALIGNMENT of flexible couplings can be speeded up with right indicator assembly using two dial indicators. This rig is easy to clamp to one half of coupling in most designs

Use two indicators for alignment

By T C CASKEY, Consulting Engineer

Misalignment of rotating machinery crops up in new and old installations. Building settling is a common cause. Aggravating the problem, many maintenance men have an idea that a flexible coupling is also a universal joint. Reading the equipment catalogs, they see that the couplings will withstand so much runout and angular misalignment. True, the couplings *will* handle the misalignment —but rotating-equipment bearings wind up taking a terrible beating.

Machinists' stethoscope is a handy tool for quick misalignment checks on ball-bearing-equipped machinery. After a little practice listening to these bearings you can usually recognize flexible-coupling misalignment. Ball bearings make a roaring sound when alignment isn't right, a clear ringing sound when the flexible coupling is properly aligned.

Bearing temperatures are another quick check for detecting misalignment. Indicating pyrometer, right, gives an instantaneous temperature reading. If temperature is above normal, suspect misalignment.

Don't overlook the engineer's precision level. I once checked an air compressor each month for a year. During that time the concrete base settled more than an inch, throwing the coupling way out of line.

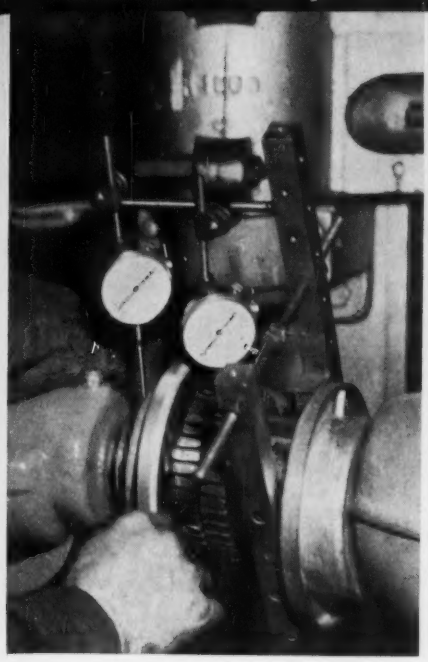
Flexible couplings are often aligned during an emergency shutdown with nothing more than a straight edge. Then months later maintenance engineers complain about bearing failures, blaming the manufacturer.

My experience shows it's better to take a few extra minutes to make the alignments and do them right. Second and third failures cost big money. But proper alignment starts with the proper tools.

Basic tools you'll need are two good dial indicators and the necessary jigs to install them on the machine. There are several good makes; many have standard attachment connectors. For my work, I take 5/16-in. dia drill rod, then make up a series of attachments in lengths I think I'll need. I turn down one end and thread for No. 10-32 machine screw threads. In this way I can select whatever mounting length the gages need to fit any job. For the gage extensions I use ¼-in. drill rod, make up a series of these attachments in various lengths, photo, lower right.

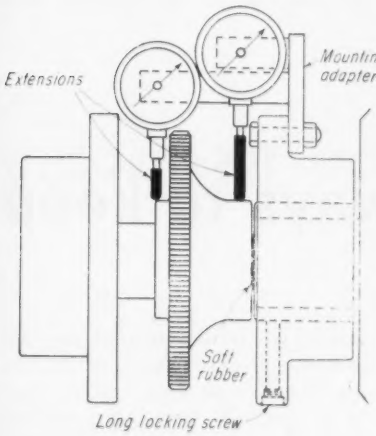
A good clamping device can be made of ⅞-in. key stock. Use two pieces, each about 12-in. long. Drill them to take ⅜-in. hold-together rods. Two of these rods are needed. The key stock is drilled on two sides and tapped at 1-in. intervals for the No. 10-32 threads of the 5/16-in. drill-rod extensions. This makes it easy to find a suitable combination of holes for positioning the indicator.

To align, open the flexible couplings and set the distance between halves according to manufacturer's instructions. Then push a piece of fairly soft rubber between the two halves, sketch at right. The two halves must be marked so they can be rotated and kept together during the test. A through bolt between the two halves on some couplings will

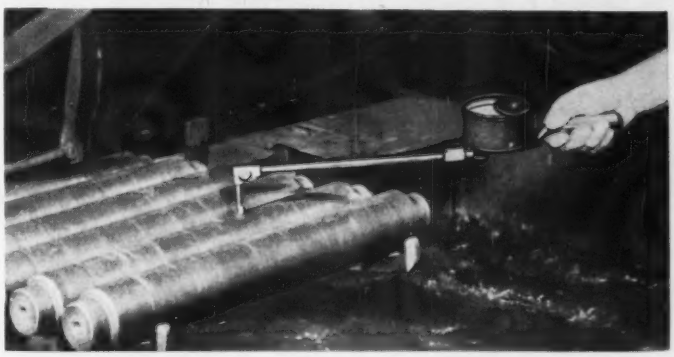


TWO INDICATORS show angular runout between two rims of coupling at one quick glance

TURN INDICATORS 180 DEG to opposite side, making sure both halves of coupling turn together. Check these readings with those taken before



EXTENSIONS of various lengths help you align every size and shape of coupling

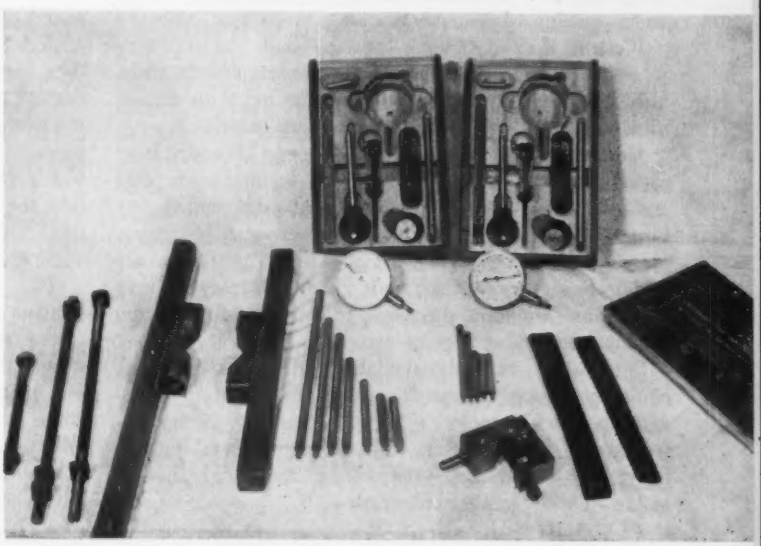


INDICATING PYROMETER of this type gives instant temperature reading. Use on bearings to check for abnormal temperature rise: sign of misalignment

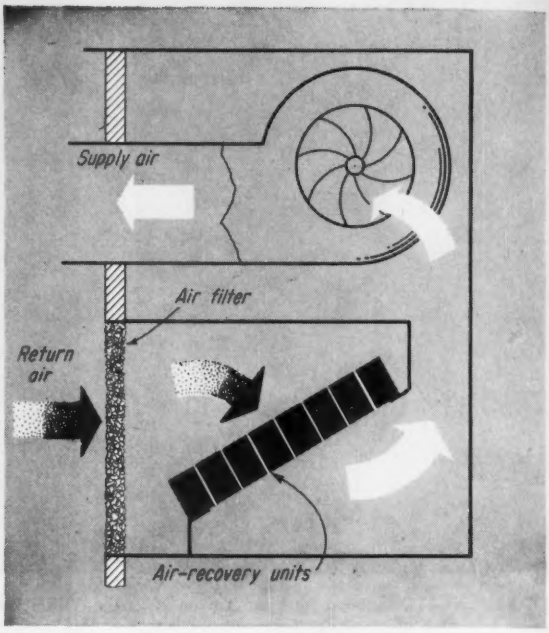
keep both halves turning together.

To check runout, set two dial indicators to straddle the coupling half. Set each indicator as near the end of each rim as possible. In this way the indicator farthest from the shaft end measures the angular runout. Distance between the two extensions is the radius of this angle.

After machine is aligned so these gages read within 0.002 in., rotate the gages 180 deg and take readings again. Angular alignment should be held within 0.001 in. per in. distance between the two indicators.



PARTS for dial indicators are made of key stock, drill rod and **other standard** materials found in most plants. Use indicators as shown above **to save time**



SATURATED activated-carbon cells are removed from duct system, returned to manufacturer and replaced with regenerated units. Here the return air first passes through filters, then recovery units strip away odors before air goes back to supply system

OPERATORS' NOTEBOOK **146**

Five ways to keep

dor-causing impurities in the indoor air we breathe come from many sources. Sometimes they're indicative of harmful aerosols and we have to get rid of them for health reasons. But even the most harmless odor is objectionable; it gives building tenants and their visitors an impression of poor ventilation.

It's true that continuous exposure dulls our olfactory senses so we become less conscious of odors after a while. Still, it's no more than good business to get those impurities out. Let's look at the odor-causing culprits.

Contaminants of inside air include: (1) odors from eating places, lavatories (2) human respiratory-process and skin emanations (3) tobacco and other smoke (4) fumes and vapors from chemical products (5) toxic gases (6) bacteria from organic products (these are minute living organisms ranging from harmless to very dangerous) (7) dirt, dust, lint (8) exhaust fumes from products of combustion.

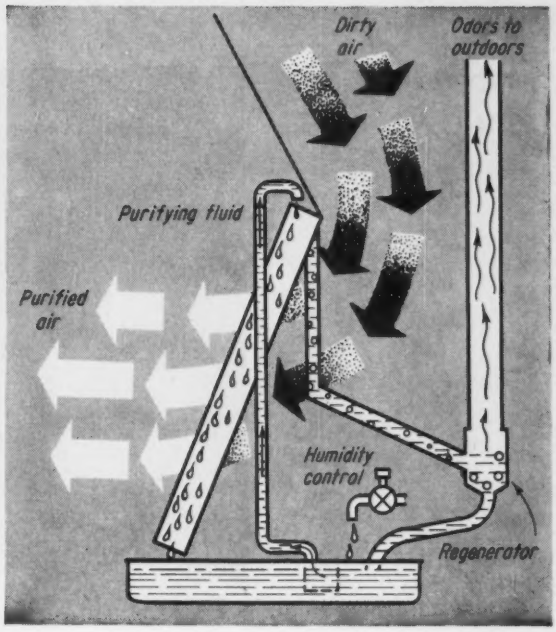
Purification methods available: (1) odor-adsorbing equipment using activated carbon (2) air sterilization with special ultraviolet-ray lamps, propylene or triethylene glycol (3) masking with ozone (4) washing the filtered air with treated water, far right, and (5) diluting inside air with cleaner outdoor air.

(1) Activated carbon has the ability to soak up some odor-bearing materials and vapors. The hard shells of coconuts, pecans and other nuts are turned to charcoal by prolonged heating at 900 C and steam treating. Resulting material has an intricate network of twisting submicroscopic canals. These canals adsorb odors; odor particles are trapped and cling to the internal surfaces of the carbon. A pound of this "molecular sponge" can soak up about half its weight in odor particles.

Perforated cells or canisters are filled with carbon, then installed in the duct sections, above right. The incoming air first flows through some type of air filter, electrostatic cleaner or washer where some aerosols are removed. Partially cleaned air flows through the carbon which takes out remaining odor causes. After some time the activated carbon becomes saturated and ineffective. Then you replace the cells, return the old ones to the manufacturer for regeneration.

(2) Air sterilization kills bacteria brought in by humans or emanating from other sources. One method places special ultraviolet-ray lamps in the air-supply ducts. Be sure to shield these lamps so the rays can't fall on the eyes and skin of occupants. Ultraviolet-ray lamps must have radiation effect of about 2600 angstrom units; one angstrom equals about 1/250-millionth in.

Propylene or triethylene glycol sprayed into the air kills bacteria. Units using these chemicals have been adopted by some large buildings in New York City. Life span of many airborne organisms depends also on relative humidity—these chemicals are most effective at



AIR-WASHING SYSTEM is placed in ductwork of bar heating and air-conditioning system where it removes smoke, odors and dust. A wet filter handles return air first. Part of odor-absorbing liquid drains to the regenerator which vents odors outside

indoor air odor-free

By STEVE ELONKA, Associate Editor

50% relative humidity. Remember that both radiation lamps and germicide mists depend for effectiveness on *reaching* the unwanted organisms.

(3) Ozone has been getting a lot of attention lately, especially the small plug-in units sold by appliance dealers for use in bars, restaurants, etc. O_3 masks odors because it has a pungent smell resembling weak chlorine.

O_3 is a powerful, unstable chemical, an isotope of oxygen. In these portable units, O_3 is prepared by introducing enough energy into oxygen to convert it to the more-active form. This can be done by chemical reaction, electrolysis, ultraviolet light or electric discharge. When you consider using it, remember that O_3 is generally regarded as *harmful* to humans. In fact, ozone is one of the substances people concerned with cleaning up dirty atmospheres generally worry about. To make sure there'll be no harm to humans, concentrations are limited to 0.01 to 0.05 parts per million parts of air. But in these low concentrations ozone isn't too effective as either a masking or a sterilizing agent. In any case, before installing these units you should check with the U.S. Dept of Agriculture to be sure they're harmless.

(4) Washing filtered air with odor-absorbing liquid is a new method. One advantage: the system is continuous, constantly cleaning the air and removing odors. Return air (and outside air if used) enters at the top and passes through the filter element; odor is removed as the air flows in close contact with a large surface area continuously bathed with the odor-absorbing chemical solution. Dust, pollen and other airborne elements are filtered out, washed into a collecting pan at the bottom. Odors removed are vented outdoors.

A portion of the solution circulates through a regenerator where a small amount of heat drives off the odors. These fumes are picked up and vented outdoors by a small blower. Connected directly to the heating or cooling equipment at times when heating or cooling isn't needed, blowers in the air-conditioning equipment continue to send air through the purifier. In winter, when the relative humidity drops below comfortable levels, a humidistat within the purifier adds the right amount of moisture. Solution evaporates as it flows over the filter.

(5) Diluting the inside circulated air with outside air is common in most air-conditioning systems. Of course, if outside air were odorless and about the right temperature, you wouldn't need air conditioning at all. It isn't, and your problem boils down to bringing in enough air to keep inside air comfortably fresh without driving up air-conditioning bills. In a 40,000-cfm system, 30,000 cfm are usually recirculated and freshened with 10,000-cfm outside air. But if you recover 6000-cfm inside air you need add only 4000-cfm outside air. This is a big saving in air conditioning. Whatever method you use, keeping your inside air odorless is good business.

PERFORMANCE
TESTING NO. 6

MANUAL TRAVERSE of gas duct requires careful layout of test connections and well-made probes. Lead wire from probe to portable potentiometer must be able to take abrasion and banging about

Representative temperature measurements are hard to get when gas flows and temperatures are uneven. These hints can help . . .

Measure gas temperature

Previous articles on performance testing have covered temperature-measurement techniques for various ranges. For measuring solids and high-velocity fluids, single-point readings may suffice. But temperatures of gases, either air or some other combination, pose an entirely different set of problems.

To begin with, gases usually are transported in ducts of large relative cross section, often resulting in wide variations in gas velocity across the duct. If flow variations coincide with large temperature variations, a single-point reading may be far from representative. Your best solution to this problem: traverse the cross section of the duct; obtain enough readings to nullify the temperature-gradient effect.

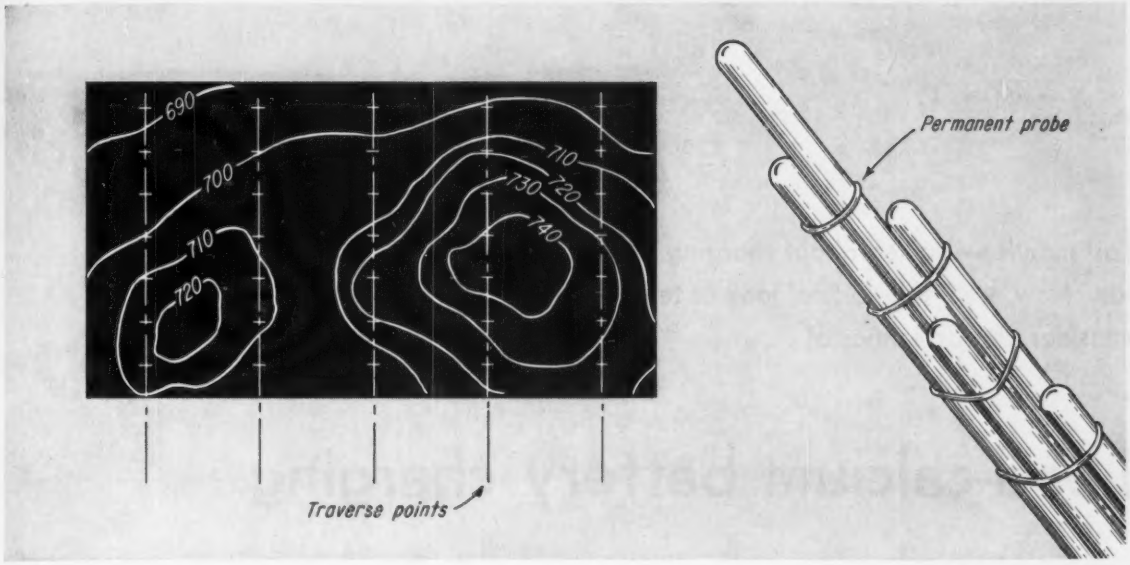
Traverse techniques differ for various systems. Most-common applications are in air ducts for heating or air-conditioning systems and ductwork associated with steam generators and accessories. We will cover air ducts in later articles. For now, let's concentrate on boiler testing since a 5-deg error in measuring exhaust-gas or inlet-air temperature has a measurable effect on efficiencies calculated by the loss method.

Temperature-measurement and traversing techniques also differ with degree of accuracy needed in your final answer. The ideal traversing pattern would obtain precisely enough readings to reach the desired accuracy and no more. Unfortunately, you'd need a crystal ball to select the exact number of traverse points beforehand. The only logical approach is to play safe and overestimate the number of points needed to get representative values.

Typical boiler-outlet cross section, above right, indicates the type of temperature unbalance you'll find under operating conditions. As a first step in traversing, divide the duct cross section into equal increments of width and depth. Since installation of test connections is likely to run into money, you may decide on far greater spacing along the duct width than point spacing through depth of the duct. Actual spacing depends on experience and configuration of the specific unit, but a good rule of thumb maintains a maximum 3-ft distance in both directions between sampling points. Added sampling points in depth are a matter of experience since temperature gradients may be greatest across the depth of a boiler outlet.

Once area grid is laid out, plan to take one reading in the center of each area. Temperature calculations must be tailored to achieve the maximum accuracy possible with the accumulated readings of your traverse.

For the most accurate results—Code tests or full-scale performance tests—each temperature reading should be accompanied by a velocity reading taken at the same point. Use the velocity readings for each traverse point to obtain a flow-weighted average temperature. Weighting is based on the product of lb-per-hr flow for each sample area and temperature measured in the center of that area.



TRAVERSE PLANNING divides cross section into equal areas with temperature readings in the center of each area. Velocity measurements at same points permit flow-weighting average temperature. Permanent probe packs save time, money in frequent test programs

by multipoint traversing

By L E STEWART
Associate Editor

Divide sum of these products by the calculated total gas weight to obtain a representative gas temperature.

Where gas velocities are too low for accurate flow measurements or test does not warrant this degree of accuracy, average the temperatures directly.

Traversing equipment usually includes thermocouple probes and portable potentiometers. Traditionally the probes are homemade affairs consisting of standard thermocouple wire strung in iron pipe, steel tubing or, for temperatures over 900 F, water-cooled probes.

Thermocouple wire used for probes must stand a lot of abuse. A little extra time spent in making up the probe will save time later. Hot junctions should be fused to form a bead; twisted wires often lose contact at the worst-possible moment because of oxidation, corrosion or mechanical damage.

Form the hot junction of calibrated wire. For economy run calibrated wire to the back end of the probe and splice in thermocouple lead wire for the remaining distance. Portion of the wire leading to the potentiometer needs heavy insulation to protect against abrasion, cutting, etc. As a final precaution, weld a U-shaped strip of wire or bar to the hot end of the probe to prevent damage to the hot junction.

Temporary probes of the homemade type will handle most of your infrequent test needs. But if you plan to take traverse readings with any frequency, a permanent installation can save much testing time and manpower.

Permanent traverse points can be assembled by building bundles of sheathed thermocouples, above right. Each successive thermocouple is placed with its hot junction one unit length behind its predecessor. This stiff bundle can be inserted through fittings of the type required for manual traverses. Outputs can be brought to one location and one man can read them using a portable potentiometer and rotary switches. Or they can be run to a multipoint recorder.

Of course, stainless-steel-sheathed thermocouples cost much more than the homemade rigs. But considering how corrosion or oxidation cut standard thermocouple wire's life span to months or even weeks, overall cost of the permanent rig looks better on an evaluated basis.

One last caution: under most testing conditions, measurement of gas temperatures over 700 F probably will require water-cooled high-velocity-thermocouple (HVT) probes. These specialized measuring tools use high-temperature radiation shields around the couple and pull high-velocity streams of gas around the couple and through the probe. All of this equipment is used to prevent heat loss from thermocouple junction to surrounding cold surfaces such as boiler tubes. Hot junction loses more heat by radiation than it recovers by convection transfer from hot gas. Our next article will cover use and design of these high-velocity thermocouple probes.

Last month we talked about charging lead-antimony batteries. Now, we'll take a final look at temperature effects and consider characteristics of . . .

Lead-calcium battery charging

By EARLE A HOXIE, The Electric Storage Battery Co

Current taken by a lead-calcium battery at a given charge voltage is less than a lead-antimony battery takes. This has a considerable effect on the time required for recharge when charging voltage is limited to a low value such as 2.17 to 2.33 volts per cell. Floating voltage used for lead-antimony cells, 2.15 volts per cell, is inadequate to keep a lead-calcium battery fully charged so a voltage of 2.15 isn't included in the following data.

Hours required to recharge lead-calcium batteries are given in table 2. This table is similar to table 1, p 163 in Jan POWER, for lead-antimony batteries. Recharge takes longer, and note that for lead-calcium batteries the value of charging voltage has a much greater effect on recharge time, while the effect of charger capacity is much less.

Table 2 shows that close to 90% of battery capacity will be available (90% discharged amp-hr returned) in a much shorter time than needed for a complete recharge. Difference between time required to replace 90% of the discharged amp-hr and time to replace 100 to 105% is greater for a lead-calcium than for a lead-antimony battery.

Comparison of time required to charge lead-calcium batteries with time for lead-antimony shows considerable variation. For example, there is practically no difference in time required to replace 90% of discharged amp-hr at a limiting voltage of 2.33 volts per cell using a charger with capacity equal to 75% of battery's 8-hr rate. Reason: practically all the charge is accomplished at constant current, before a voltage of 2.33 volts per cell is reached.

At lower voltages and with chargers of lower capacity, however, time required for the lead-calcium battery increases as much as 500% if the charge is continued until 105 or 110% of the discharged amp-hr are returned. Reason for the longer charge time: a large portion of the charge is at constant potential and the lower currents taken by the lead-calcium battery prolong the charge.

Temperature has considerable effect on the current taken by a lead-acid battery on charge at a given potential. In all preceding data we've assumed the battery is at 77 F. As a general rule of thumb, let's consider that current taken by a fully charged battery at a given charge voltage, within the range of 2.15 to 2.33 volts per cell, doubles for each 15-F rise in temperature and halves for each 15-F decrease.

When the battery is discharged, temperature doesn't influence current taken at a given charge voltage as much as when the battery is fully charged. From a limited amount of data, an increase in charging current over a range of 35 to 50% has been noted for a 15-F rise in temperature. Using an approximate average of 42%, we may consider that at the start of a charge the current will increase 42% for each 15-F rise in battery temperature over the previous values and for every 15-F drop the charging current will decrease 1/1.42 or 0.705 times the previous value. We can derive these formulas:

At the start of charge:

A: $I_2 = I_1\ (1.0234^n)$

B: $I_2 = I_1 / 1.0234^n$

When fully charged:

A: $I_2 = I_1\ (1.0473^n)$

B: $I_2 = I_1 / 1.0473^n$

Where:

A = battery temperature above given value

B = battery temperature below given value

I_1 = Current taken at given temperature

I_2 = Current taken at higher or lower temperature

n = Coefficient equal to number of degrees F above or below given value

Effect of temperature on charging current may be considered the same for both lead-antimony and lead-calcium batteries.

It isn't necessary to make any change in the floating voltage when operating at various temperatures. Current taken by the battery at normal floating voltage corrects itself automatically to battery's needs.

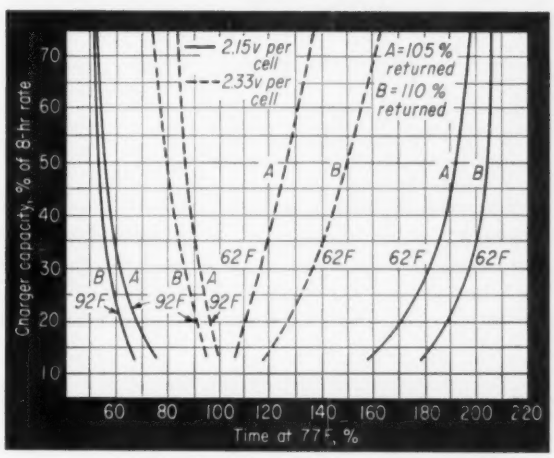
Time required for recharge at a battery temperature above 77 F obviously will be less than when the

2—Hours to recharge lead-calcium batteries

Charger capacity, % of battery's 8-hr amp rate	Constant potential volts per cell	10% discharged				50% discharged				100% discharged			
		Amp-hr returned, %				Amp-hr returned, %				Amp-hr returned, %			
		90	100	105	110	90	100	105	110	90	100	105	110
12.5	2.17	9.6	21.7	56	105	44	97	273	516	75	165	492	972
12.5	2.22	5.9	9.0	23.7	46.4	29.5	44	117	231	58.4	82	221	448
12.5	2.33	5.8	6.5	9.4	14.7	28.8	33	46	72	57.6	65	92	142
25	2.17	7.5	19.7	54	103	36	89	265	508	55.4	145	472	952
25	2.22	3.5	6.6	21.3	44	17	31	105	218	32	56	195	422
25	2.33	2.9	3.3	6.2	11.5	14.4	16.6	29.4	55.7	28.8	33.4	60	111
40	2.17	7.1	19.3	53	102	33	86	262	506	49	139	466	946
40	2.22	2.7	5.8	20.5	43.2	13	27	101	214	23.5	47	186	413
40	2.33	1.8	2.2	5.0	10.4	9	10.9	23.7	50	18	21.7	48	99
75	2.17	6.9	19.0	53	101	31.5	85	261	504	45	135	462	942
75	2.22	2.3	5.3	20	42.7	13	27	101	212	18	42	181	408
75	2.33	1.0	1.4	4.2	9.6	4.8	6.7	19.5	46	9.8	13.5	40	91

3—Actual charge voltages

Amp per 100-amp-hr capacity at 8-hr rate	Volts per cell	
	Lead-antimony	Lead-calcium
10	2.69	2.77
1	2.41	2.54
0.1	2.18	2.35



4 **EFFECTS** of battery temperatures 15-F higher or lower than 77 F on time required for recharge; specific gravity is 1.210

battery temperature is at 77 F and, conversely, a longer time will be required for recharge if the battery is at a temperature below 77 F. Fig. 4 shows effect of battery temperature on time required for recharge at temperatures 15-F higher or lower than 77 F. It covers 105 and 110% of discharged amp-hr returned at the maximum and minimum charging voltages of 2.33 and 2.15 v per cell with chargers of various capacities.

Data for these articles, as we mentioned at the beginning, is based on typical charging curves. However, voltage required to produce a given charge current isn't exactly the same for all cells of this general type. Some batteries will take somewhat more or less current, particularly toward the end of the charge. And some batteries, especially the lead-antimony type that have been in service for many years, may take higher charge currents at a given voltage. This is particularly true toward the end of the charge, so an old battery will take somewhat less time for charging.

Specifically, estimated values of times required for charging given in this article are based on fully charged voltages as shown in table 3. They're considered typical of batteries in service at a battery temperature of 77F. Particular batteries may vary.

Charging at constant potential, the very-low current rates involved toward the end of a charge at low voltages such as 2.15 and 2.17 could deviate from average values used. This could appreciably affect time required to put in the last 5 or 10% of the discharged amp-hr. Also, because of the very-low current rates toward the end of a charge, there may be some question whether all the charge current is effective. Times required for recharge in our curves and tabulations should not be considered precise values but rather reasonable approximations.

EDITOR'S NOTE: *This article is the last of a 3-part series. If you're interested in more details on constant-potential charging, you may obtain a report by E A Hoxie from the Electric Storage Battery Co, 2 Penn Center Plaza, Philadelphia, Pa. It includes expanded treatment of the curves and tabulations of recharge times relating to both grid types.*

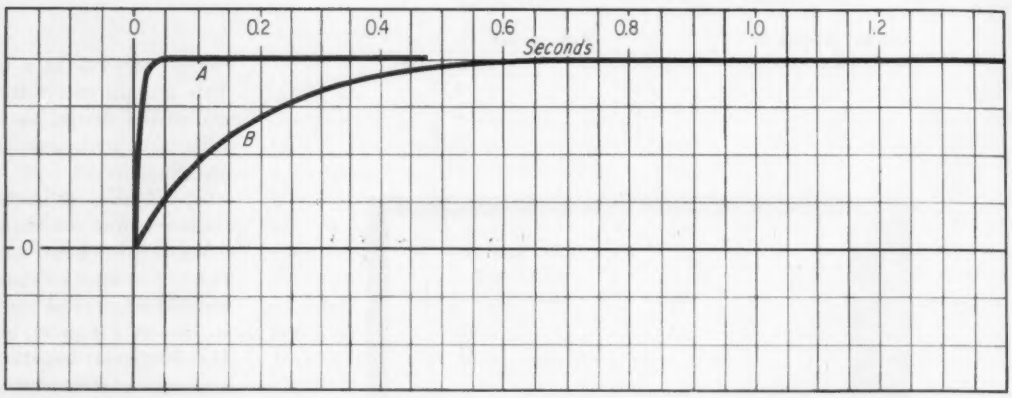
Plant Electrical Fact File

NO. 55: SHORT CIRCUITS

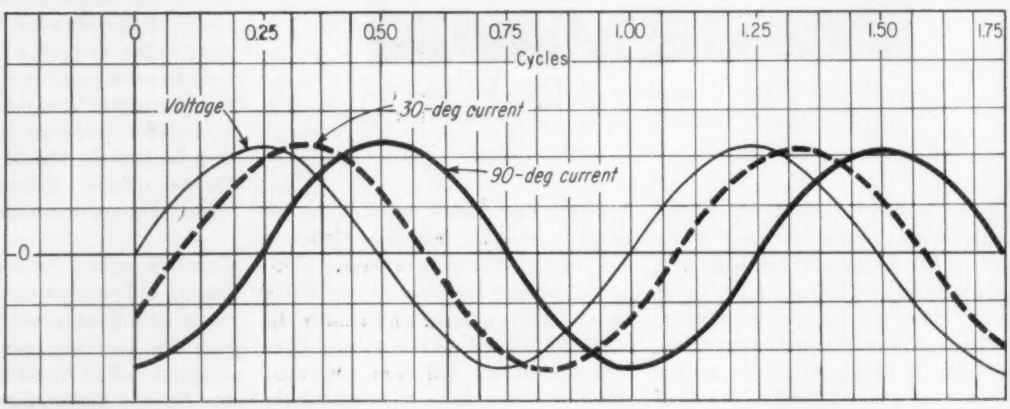
What happens in a short circuit?

By NORMAN PEACH, Associate Editor

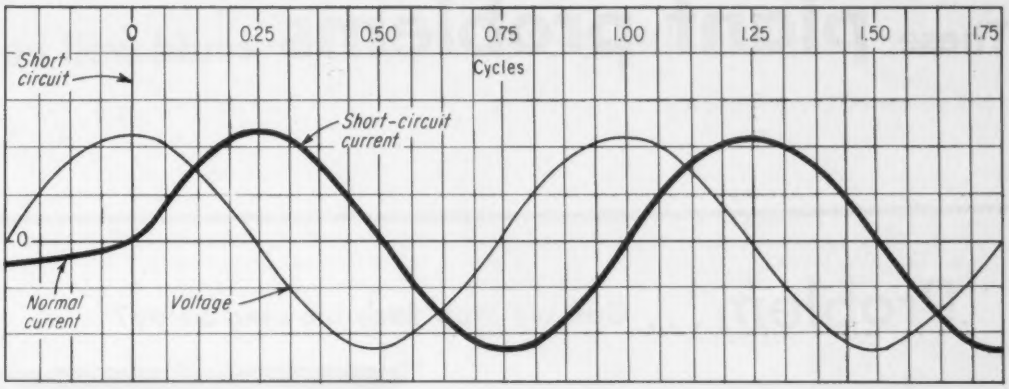
When a short circuit occurs on an ac circuit result isn't simply "more current." How the short circuit behaves in first few cycles of its existence is important in selecting proper circuit breakers. Newly proposed ASA Switchgear Standards have spurred interest in this problem. So let's take a close look at what happens when a phase-to-phase short-circuit occurs, and also see some prominent factors influencing the short circuit current.



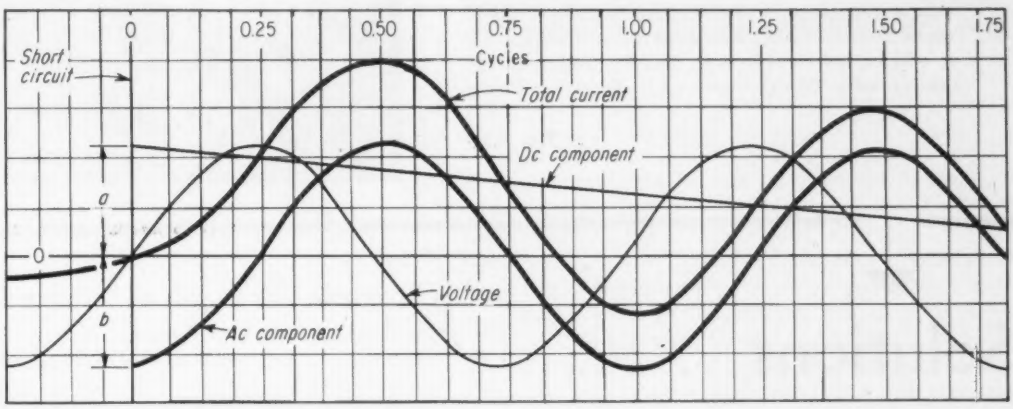
1 **DC SHORT CIRCUIT** is equivalent to closing a switch on a low-resistance circuit. Current can't change instantaneously in a circuit that has inductance—and while for practical purposes a circuit may be considered to have only resistance, there's always some inductance. This is enough to delay rise of current (curve *A*). Curve *B* represents circuit with more inductance



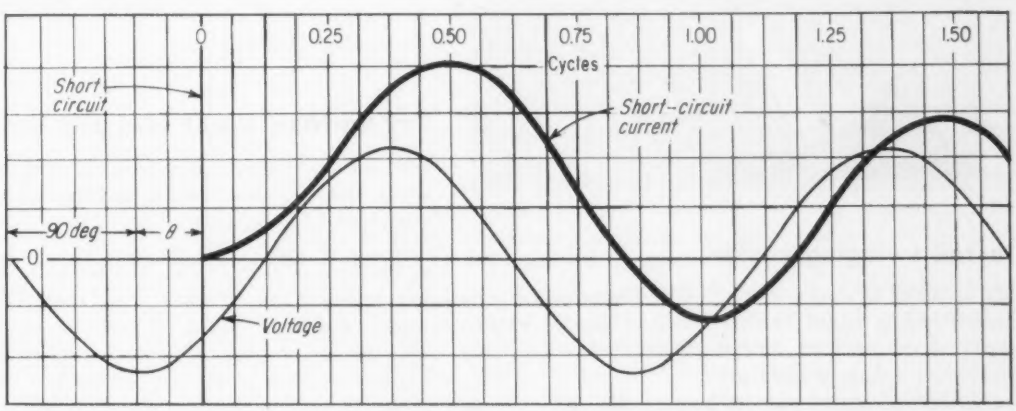
2 **AC SHORT CIRCUIT** is affected importantly by power factor. Short-circuit current is out of phase with line voltage. In calculations for system protection it's customary to assume zero power factor—that current lags voltage by 90 deg. This is usually about correct since system reactance *X* is usually many times resistance *R*. Zero pf is a condition of the worst situation



3 **SYMMETRICAL** short-circuit current appears when fault occurs at maximum of voltage wave (this is the instant when current will be zero in zero-pf circuit). Current rises approximately along sine curve, meeting requirement that current can't change instantaneously in an inductive circuit. Time scale is in cycles after fault. Short-circuit current keeps symmetrical



4 **ASYMMETRICAL** short-circuit current results when fault occurs at zero voltage. If fault current were symmetrical it would have to rise instantly to maximum. Since this is impossible, an equal countervoltage exists ($b - a = 0$). Total current is sum of ac (symmetrical) and dc (countervoltage) components. Because some resistance exists, dc component gradually decays

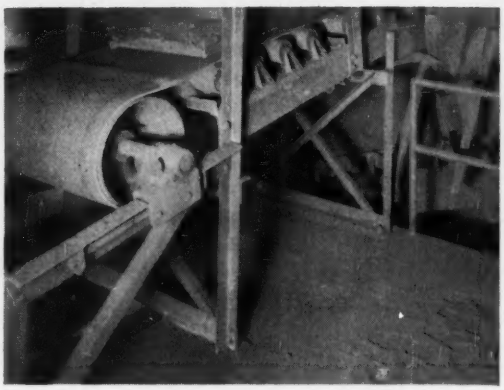


5 **X/R RATIO** influences offset in circuits with significant resistance. With $\theta = \tan X/R$, the maximum offset will result when fault occurs at 90 deg + θ after the previous voltage zero. Short-circuit current is symmetrical when fault occurs 90-deg (.25-cycle) later than this point. Dc component decays because of resistance: the short-circuit current becomes symmetrical

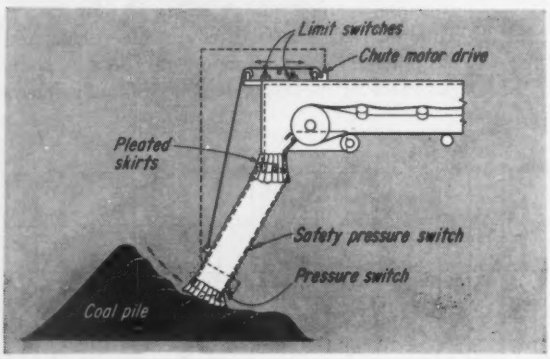
These **plant problems** could well be yours...

Problem... Can we stop fines blowing away?

Our coal pile contains 43,000 tons of bituminous aggregate of which 50% is fines and about 50% of 2½ in. The coal is oil-treated at the mines. Our problem—coal falls from a conveyor boom for a distance of 8 to 12 feet, and fines are carried away on windy days. Dust is a nuisance to nearby offices and homes and of course there is waste. We cannot water down the pile as coal cannot contain more than 8% moisture. Can readers solve this problem?—*EJ, November* POWER



Solutions...



Install swinging chute

My solution is shown above. A discharge chute with hinged end is added to *EJ*'s conveyor boom. Pleated skirts of rubber sheet located at the chute's knee and end reduce leakage at junctions.

Automatic control permits keeping the end of chute as close as possible to coal pile. A pressure switch in connection with the chute motor drive raises or lowers the hinged chute a fixed amount as soon as coal level starts to climb above the pleated skirt and into the chute.

Limit switches invert angular rotation of the chute at ends of movement, at the same time raising or translating conveyor boom a fixed amount. Safety pressure switch prevents overfilling and consequent damage to conveyor belt.

J BORESTA, *Englewood, N. J.*

Try wetting agent plus pile sealer

Dust nuisance usually is a problem over an entire conveyor system rather than a single point, although the one point *EJ* complains of is certainly the most prominent. A wetting system as described in *Cut coal dust at small added cost*, POWER, Oct 1954 would be effective in controlling this nuisance. Only about 1½% moisture would need to be added. If costs for this arrangement are excessive and manual control is adequate, batch mixing and use of a small pump may suffice for local application of wetting agent at major trouble spot.

An alternate method of control which is not as good as the wetting agent is to provide a chute to confine the coal to a shorter drop to the field level. This could be further refined by employing a cyclone-fan arrange-

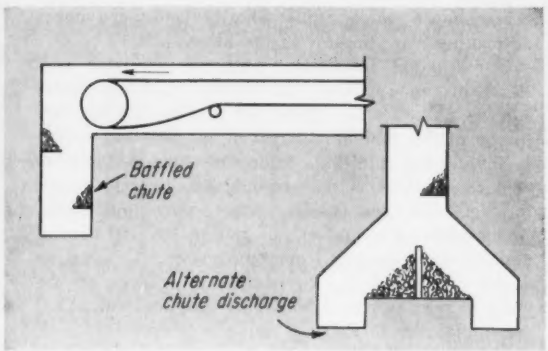
...Here's how Power readers would tackle them

LAWSON STEWART, Associate Editor

ment exhausting from the spill point on the conveyor.

In addition to the oil treatment given the coal at the mine, it seems that sealing the pile with a coal-gas tar would also be necessary to reduce surface loss from windage alone since fines run 50%.

M L MYERS, *Concord, Tenn.*



Cut coal velocity in discharge chute

The installation of an enclosed vertical chute, as shown above, will diminish fines loss. The free-fan is no less than 8 ft—no more than 12 ft. So the vertical permanent chute can be 8-ft long.

Reducing velocity by placing staggered horizontal solid plates will result in a more "quiet" stacking. Another effect of the reduced velocity is the greatly diminished degradation or attrition of the coal that becomes a waste in conventional stacking.

The alternate of expanding the enclosed vertical chute would permit a wider stack.

K I JOHNSON, *Birmingham, Ala.*

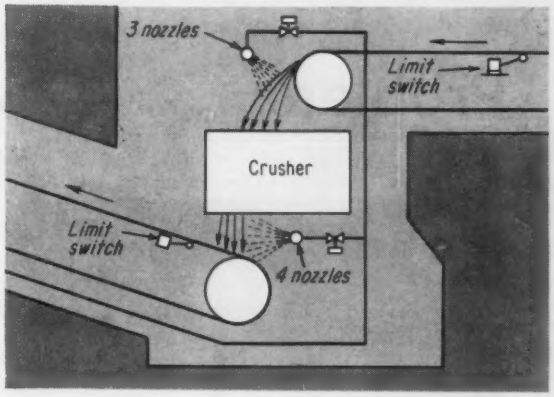
Install a telescoping chute

Why not enclose the area surrounding drop zone with a telescoping chute? This device could be raised or lowered by a simple pulley and cable arrangement, motor operated from a remote location by conveyor operator.

This way the fines could not be blown away and would only be exposed to the wind from the bottom of the chute to the top of the pile, probably 2 or 3 in. Also, operator could pinpoint the area of drop.

Experience has shown that when you're handling coal in chutes or hoppers, a good grade of abrasion-resistant steel is a very economical investment.

R A ROUSSEAU, *New Bedford, Mass.*



We used a wetting agent

We solved coal-dust problems at our plant by installing a dust-control spray system using water mixed with industrial wetting agent. This system is energized anytime coal is on conveyor belts. It features a proportioning controller to automatically mix water and wetting agent at a ratio of 400 parts agent per million parts water. With this arrangement, we add less than 1% moisture to our incoming coal when sprays are operated continuously, and have practically eliminated dust problems.

In our system water-wetting-agent mixture is sprayed into falling coal stream at four different points: rotary car dumper, discharge of apron feeders, discharge of breaker and discharge of crusher. All four of these points used to be trouble spots for us. Perhaps *EJ* will only have to spray at one location to solve his problem.

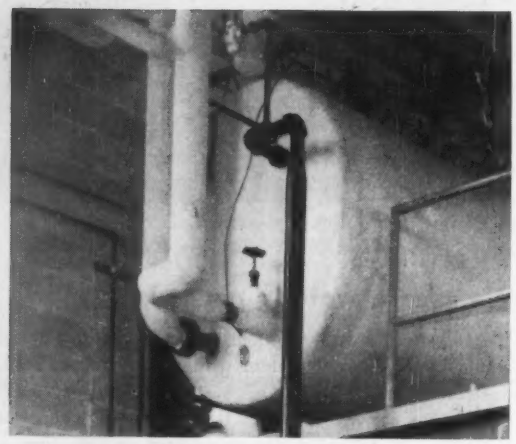
Drawing, above, shows how spray system is applied to breaker and crusher discharges. Once the car-dumper operator engages his selector switch, operation of the sprays is controlled by limit switches on the conveyor belts. Switches are energized by the weight of coal on the belts, in turn energize solenoid valves to admit liquid to the spray nozzles. The coal stream is approximately 48-in. wide at both breaker and crusher discharges, and this is adequately covered by a row of three nozzles at the breaker discharge and by a row of four nozzles at the crusher discharge as shown above.

One word of caution. If system is to be used outdoors, make sure supply header can be completely drained to guard against freezing anytime sprays will be out of use for more than a few hours.

J L WISE, *Reading, Pa.*

Want some help on plant problems? Send us any of your design or operating headaches for *Power* reader comment

Problem . . . How can we improve maintenance and operation record for new heater?



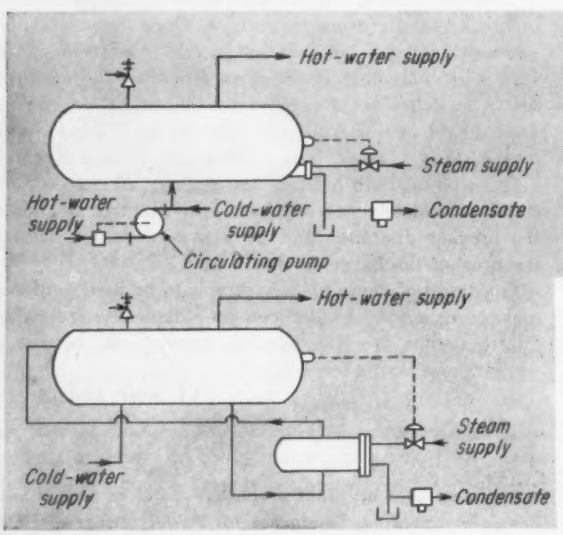
We plan to install a new water heater for the mine change-house water supply shortly, and have hopes of making some improvements meanwhile.

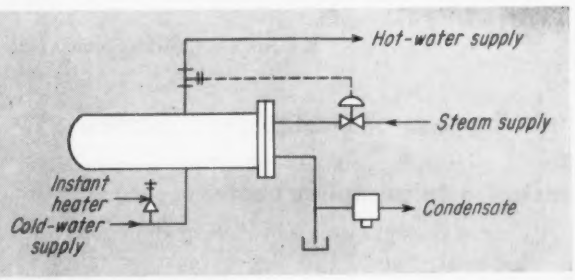
Our original installation had the regulator two-thirds of the way from the bottom of the hot-water storage tank. We have been told that moving our regulator to the midpoint may supply more hot water.

Because regulator-bulb failure meant a shutdown to replace it in the shell, we would like to weld a well in place in the new tank to permit exchange of bulbs.

Our problem is first one of getting the best control and highest capacity from our heater. To help us decide we would like to hear from readers on the effect of regulator level on capacity and control. Also, we would like to know if using a temperature well would make the regulator's bulb too insensitive.—*MMK, November* POWER

Solutions . . .





Select system for your needs

Many heating-system designs having a temperature regulator that modulates thermal input require a heat source greatly in excess of that needed for normal load. This results from designing for peak conditions, which may be as high as 200% of normal. To satisfy these

requirements, boilers and auxiliaries are larger than necessary. Also, during peak periods, operating efficiency is less than at normal load.

One method for minimizing equipment size and obtaining optimum operating conditions is shown in top sketch, left. This design includes a closed storage tank having a heating element located near the bottom of the shell. A circulating-water pump is employed to limit stratification resulting from thermal gradients. Required stored-water temperature is maintained by locating the thermostatic bulb near the tank center. This permits measuring a nearly average water temperature. If bulb is lower, measured temperature will be greater than average because of its proximity to the heating element.

Bottom sketch shows an alternate design with external heater. This arrangement allows inspection and maintenance of the heating element without requiring draining the tank. Method of sensing stored-water temperature and its control is the same as for the first design.

For some installations, an instantaneous heater may be employed which offers lower first cost. Capacities as high as 10,000 gph having a heating range of 40 to 180 F are typical. Top, right is an elementary diagram indicating principal components. With this design the thermostatic bulb is located in the hot-water line leaving the heater. This permits modulating the steam-control valve in direct response to effluent temperature, rather than the stored-water temperature as characteristic of tank installation.

For any of the schemes, the temperature-sensing bulb may be located inside a well. This allows its removal without requiring shutting down and draining the system. Sensitivity of temperature response will not be influenced by its use. —H B WAYNE, *Woodhaven, N. Y.*

Locate bulb in well

(1) Regulator bulb should be located in a well. Advantage is that bulb could be removed without draining the tank. Sensitivity of the bulb in a well is negligibly affected in this type of installation.

(2) Accepted practice is to install regulator well two-thirds of the way up from the bottom of the tank. At this point, regulator reflects most nearly the average temperature conditions within the tank.

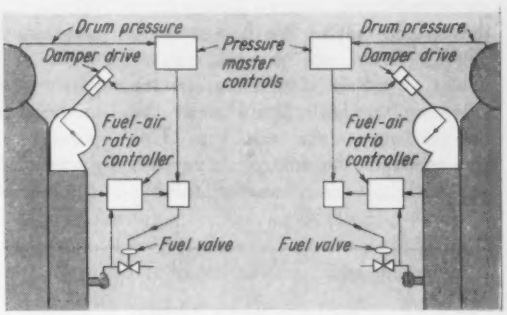
(3) Be sure that the tank has ample hot-water capacity and rapid recovery—determined by amount of water to be withdrawn from the tank. Recovery is determined by capacity of the tank, heating surface of the coils, pressure (temperature) of the steam entering the heating coils vs amount of water being drawn from the tank. Be sure a steam trap of adequate size is installed in the condensate-return line. —L E POLIKOFF, *Bethpage, N. Y.*

Your February problems

Why do cotter pins break?

We have an engine-driven air compressor which seems to be in trouble. Unit supplies 210 cfm of 100-psig air and is driven by a 51-bhp 6-cylinder 1200-rpm internal-combustion engine. Basically, operation has been completely satisfactory.

Recently the unit completed 1000-hr operation and was opened up for inspection. We found pieces of cotter pins mixed with the sludge in the crankcase. Examination showed they came from the connecting-rod bearing caps. There was no pattern of breakage and luckily the castellated nuts remained tight. Remaining cotter pins were removed and found in good condition. Our problem: what caused this random failure and how can we guard against it?—*TDO*



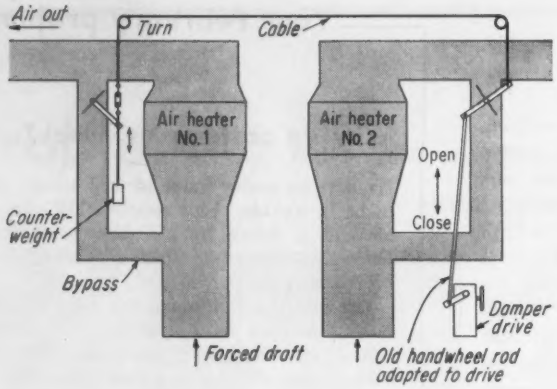
What makes our boiler controls hunt?

We have two 30,000-lb-per-hr watertube boilers operating at 225 psig supplying saturated steam for process and plant heat. Units include separate pneumatic combustion controls, single-element thermal feedwater regulators and separate pneumatic pressure masters. Each master positions its fuel and air in parallel. Combustion controller resets air-fuel ratio. After two years' satisfactory operation we replaced some worn parts and our own men adjusted controls. We were careful to get duplicate settings of all controls and set both masters for a 5-lb range in pressure.

Now both boilers hunt. They seem to fight for load. We must run one unit on hand to quiet hunting. We have checked controls and find nothing wrong. Can someone help us hunt down the hunting?—*JAS*

Sit down right now and answer one or both problems. We'll pay extra for answers with photos or sketches

Timely **practical ideas** to help solve



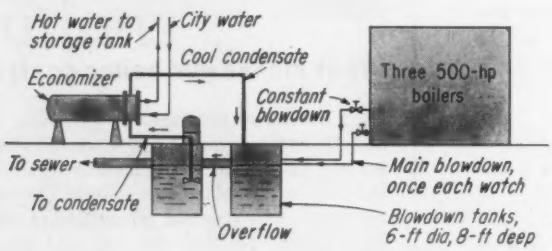
Now, bypass dampers are easily controlled

Air-heater bypass dampers on our No. 1 boiler had handwheels operated from the fan floor. Boiler control panel is located some distance from these handwheels. We had a spare damper drive and several selector valves. First we installed a selector valve on the boiler panel near the flue-gas-temperature recorders. This was piped to the control drive with a length of ¼-in copper tubing.

The old handwheel drives were removed; we connected dampers as shown in sketch. As the dampers are operated by a cable, we had to install a turnbuckle and a counterweight.

Our operators use the bypass dampers to control gas temperature out of the air heaters. Keeping this temperature at a minimum of 275 F reduces air-heater corrosion.

G F BRILL, *Lake Charles, La.*



Circulating boiler blowdown saves $4600 a year

Using an economizer in the blowdown line from boilers is nothing new. But at our Statler Hilton Hotel in Los Angeles we hooked a small 14-gpm pump to one of our large 6-ft diameter by 8-ft deep blowdown tanks. Tanks, sketch, are used to store hot condensate from the continuous blowdown of our hotel's three 500-hp steam generators.

The ½-hp sump pump—type used to keep basements dry—circulates hot condensate continuously. We find this much more economical than running the blowdown once through an economizer, usual practice in many plants. Result: we obtain better transfer with a small economizer.

Our estimated saving in fuel oil is about $4600 per year. This includes the cost of water previously used to cool the condensate before it went to the sewer. Hotels need a lot of hot water and these large tanks store plenty of heat for peak loads.

E PODMAYER, *Los Angeles, Calif.*

What fan speed?

Tip speed of induced-draft fans must be great to develop the static pressures required by heat- and dust-recovery apparatus used in modern steam-generating units. That means abrasive dust carried in the flue gases impinges heavily on the fan blades, wheel and housing. Rapid erosion or wear is to be expected.

Tip speed required for a given static pressure will be about the same whether a large-diameter or small-diameter fan wheel is used. The rotational speed can therefore be reduced as the diameter of the fan wheel increases. Lower rotational speed of a large fan reduces the impact between abrasive particles and parts of the fan, producing much less erosion. But large-diameter fans have thicker blades and much greater areas over which erosion can be dispersed.

For any given size of fan, rotational speed required is almost directly proportional to steaming rate of the steam generator served. Erosion produced by abrasion is commonly admitted to be proportional to the cube of the fan speed. Some authorities think it's proportional to the fifth power of the speed. So it's evident that to cut erosion, fan should not run at any greater rotational speed than load carried by the steam-generating unit requires.

L V ANDREWS, *Dunedin, Fla.*

Can you top Marmy?

Many of Marmy's 150 stories to date have been based on incidents sent in by you POWER readers. Why not send me the most unusual engineering incident you know and see if Marmy can tell it so it gets into print for posterity. If it's accepted you'll get a small check for your effort and a laugh.—STEVE ELONKA

your tricky design and maintenance problems

By STEVE ELONKA, Associate Editor

Big oil mystery

About six years ago I started as plant engineer in a chemical plant. The old retiring engineer told me they had one problem they'd lived with for ten years. "Ten years," I echoed. "That's right," said the old-timer. "It sounds crazy but it's true." He had over 30 years' experience in that plant, so I was worried. "Don't let it get you down," the old-timer encouraged me, "new blood is what this problem needs."

He explained: "At the beginning of each heating season the boil r on the line goes crazy. Large gobbets of brown oil show up in the gage glass on the surface. The entire 10-in. of water bounces up and down. The boiler obviously foams and primes. This condition lasts about three days, then everything goes back to normal."

Three years later, after tracing 121 traps in condensate-return lines, I was at a complete loss. I knew the oil was coming from the traps, but I couldn't figure out how.

As the third heating season started, I went into the shop to check a blueprint with the pipe foreman. I noticed a mechanic working on steam traps. I soon learned that 40 traps were overhauled at the beginning of each heating season. Naturally, the mechanic used powdered graphite and cylinder oil for each trap's cover gasket. But in his stepped-up pace to complete the 40 traps in a week he wasn't too careful in applying the graphite. And he had done this job for 13 years.

Bottom-inlet top-outlet traps were designed so bottom-inlet hole was recessed about 3/8 in. Because the opening was higher than the casting's bottom, excess oil accumulated. Multiply this amount by 40 traps and you have a small oilwell. At start of each heating season all the heaters were turned on at same time throughout the plant, and the fireworks began.

D STUART, *Newark, N. J.*

What would you have done?

It was with some dismay and a lot of fancy language expressing my opinion of a certain installation engineer that I took over my first job as operating engineer. Among other things an air-conditioning system was put in my charge. The air was cooled by a couple of banks of chilled-water sprays. This spray water was recirculated through the chiller by a direct-connected pump. So far so good.

But the installation engineer hadn't provided drain piping from the pump's packing gland. Even worse, pump and motor were mounted directly on the floor with no space for me to install such piping. Only way I had to catch the slow drip from the packing was a shallow pan which had to be emptied twice a day. I couldn't wait for a shutdown after hours because there *was* none—this system ran 24 hours a day, seven days a week. Things would have to wait until winter.

While I wiped the sweat from my forehead an idea came to me. I took two absorbent strips of cloth and placed one end of each in the drain pan. The other ends hung from each side of the motor where its warm exhaust air hit them. The ends in the pan soaked up moisture, capillary action started it through the cloth to the ends near the motor, and the warm air evaporated it. This system worked fine as long as I kept the packing gland from leaking excessively. What would *you* have done?—J BELUNAS, *Brooklyn, N. Y.*

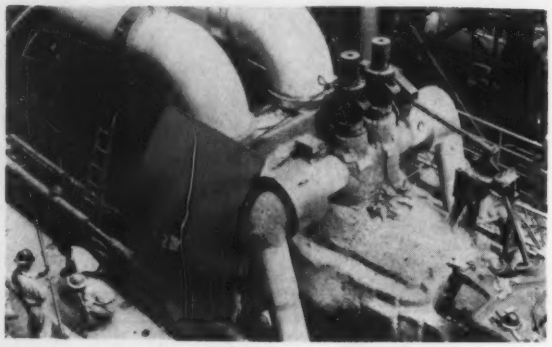
Use that velocity!

Did you know that gases leaving the discharge of a fan contain considerable energy because of their high velocity? This energy can be largely recovered (velocity pressure converted to static pressure) if a long straight discharge duct is connected to the fan. Fan manufacturers base performance on testing under excellent conditions—test-block performance.

But it's seldom possible to provide such ideal conditions on an installation. Discharge dampers, elbows, changes in duct shape or size all act to prevent full conversion of velocity to static pressure. So installed performance of a fan is usually less than its test-block performance.

L V ANDREWS, *Dunedin, Fla.*

More **practical ideas**



Holes punched in insulation cement speed drying

Insulation for this steam turbine, photo, must withstand high temperatures and be easy to apply to irregular steel surfaces. This 175,000-kw turbine has spun mineral-wool insulating cement that withstands 1800 F.

Mineral-wool cement around h-p shell varies from thickness of 10 in. on hottest part (1050 F) to 7½ in. on coolest section (800 F). Cement on the unit is reinforced with 1-in.-mesh galvanized woven-wire netting.

Because steam would be generated by any moisture trapped in the finished insulation, each course of cement was allowed to dry completely. Cement was put on in 2-in. layers. To speed drying, small moisture exhaust holes were punched in the cement, shown at elbow in photo.

—Courtesy, Baldwin-Hill Co, Trenton, N. J.

My biggest boner

Many years ago I had to change the crankcase oil in a large air compressor. After I had completed the job, there were three or four gal of old oil left. I told my fireman helper, "throw the old oil on top of the coal." Shortly thereafter I heard an ominous "BOOM" from the boiler house. Rushing in I found the fireman halfway up the coal pile. His eyebrows were scorched and his beautiful red mustache was gone. But otherwise he was not seriously burned.

I should have emphasized the coal *pile*, for he actually opened the fire door and threw the oil on top of the live coal in the furnace. Since that day I give instructions in detail, especially where mistakes are possible and an accident might happen.

F WALKER, *Montreal, Que.*

Here's what I did!

L N Page's description of the governor problem aboard his Liberty ship was interesting (Sept 1960, p 225). I had a similar experience on a Liberty in wartime—two of three generators had to be running at all times because of the degaussing load. Lights would flicker each time No. 3 unit was paralleled. I too checked brushes and commutator and even undercut the mica on this unit, but to no avail. In Casablanca harbor, I stripped the engine and started to check out the valve setting, intending to use a trammel to position the flywheel from a punch mark in the deck.

While removing the flywheel guard, I noticed the tension-adjusting nuts on each spring were set in different positions. I checked length of thread extending beyond the nut on the other idle engine. Then I reset both nuts on No. 3 governor to this same position. The valve setting checked out perfectly. Unit was reassembled and paralleled with the operating unit which, in turn, was secured so that only No. 3 carried the load. Lights stopped flickering—apparently the unbalanced force on the valve's eccentric arm had been enough to cause a periodic variation in generator speed.

That evening at dinner we told the chief that No. 3 engine was in operation. He didn't believe it and had to go below to see for himself! Then he was satisfied.

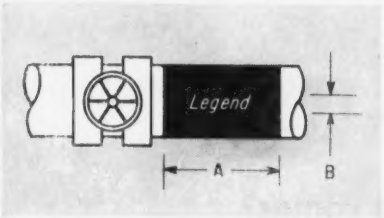
M KRAUS, *Hillsdale, N.J.*

The double-can trick

Maintenance men can save paint and work when brush painting by placing the paint can in a bucket or pail, sketch. This pail catches paint as it drips down the side of the paint can. Paint accumulates for reuse; trick also prevents paint can from being knocked over easily. This idea has saved us many a messy cleanup job.

F LETTINO, *Long Island City, N. Y.*

ASA Standards identify materials handled by color, give proper lettering size



Line service	Color Band	Color Legend
Fire protection	red	white
Dangerous	yellow	black
Safe	green	black
Protective	blue	white

OD of pipe or covering, in.	A, in.	B, in.
¾ to 1¼	8	½
1½ to 2	8	¾
2½ to 6	12	1¼
8 to 10	24	2½
Over 10	32	3½

Dangerous materials need standard pipe and container markings

By WILLIAM A HOMER,* Bechtel Corp

Safe handling of dangerous chemicals is always difficult in plants where they are not part of the prime process; secondary in the operation, they tend to seem less hazardous. Such is the case in many industrial water-treatment and waste-disposal plants. To avoid injury you have to be more than just careful. Of course, each chemical has its own handling rules. But there are two common areas where general precautions hold good—pipe identification and container marking.

Many systems of pipe marking are in effect to hold down accidents. Some are used by just one company; some are common to an industry; some cut across industry lines. But ASA Standards for pipe marking and identification can be adopted by all industries in common. Then operators and maintenance men won't have to relearn from plant to plant and run the risk of accident through mistake or confusion.

These standards are necessarily general, of course, and they do leave room for slight modification to meet special situations. Sometimes you may want to differentiate between several materials under one classification. Example: dangerous materials may be coded in yellow or shades of orange; safe materials in green or the achromatic colors—white, black, gray or aluminum. If the entire pipeline is not painted with the code color, have enough color bands to identify it positively, especially at valves, turns or where it goes through walls.

Be sure lettering is turned toward the viewer so he can see it easily. Table, above, shows proper letter size. For pipe smaller than ¾ in. a tag is better, since lettering on the pipe might be unreadable.

Containers for dangerous chemicals should be clearly labeled. Some suggestions of the Manufacturing Chemists' Assn, right, are for common water-treatment chemicals. The material is named in large print and a brief statement of its dangers given. Then come precautions for handling and specific directions for care of victims of overexposure.

Attention to these two areas of chemical handling—pipe identification and container labeling—can cut down accident-provoking mistakes.

*Formerly with Graver Water Conditioning Co

Warning labels give emergency instructions

SULFURIC ACID

Danger! Causes severe burns

Do not get in eyes, on skin or clothing.
In case of contact, immediately flush skin with plenty of water for at least 15 minutes; for eyes get medical attention.
Do not add water to contents while in a container because of violent reaction.

SODIUM HYDROXIDE (Caustic soda)

Warning! Causes severe burns to skin and eyes

Avoid contact with skin, eyes and clothing.
Do not take internally.
When handling, wear goggles or face shield. While making solution, add sodium hydroxide slowly to surface of solution to avoid violent spattering.
In case of contact, immediately flush skin with plenty of water and wash with vinegar; for eyes, flush with plenty of water for at least 15 minutes and get medical attention.

CHLORINE

Danger! Hazardous liquid and gas under pressure

Avoid breathing air containing this gas.
Avoid contact with skin or eyes.
Do not heat cylinders.
Have available emergency gas masks approved by U.S. Bureau of Mines for chlorine service.
Handle and use only in accordance with practice recommended by the chlorine producer.
In case of exposure, remove patient to fresh air, keep him warm and quiet and send for a physician.

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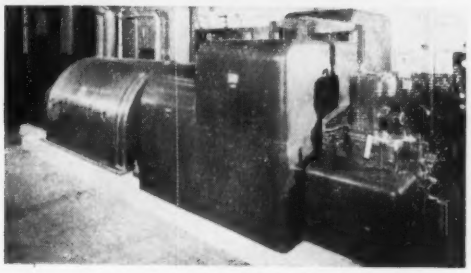

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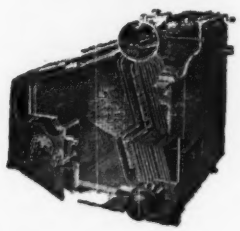

# Steam/hr.	Key	PSI	Temp.
122,500	DF	565	850
121,650	DF	565	850
60,000	SF	435	750
74,000	H	280	500
55,000	A	240	—

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600	G.E.	Synch.	480	900
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450	Allis Ch.	Sq. Cage	2300/440	720
400	Whse.	Sq. Cage	2200	514
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400	El. Machy.	Synch.	2300/4000	400
400	Whse.	Sq. Cage	440	1200
350	G.E.	Slipring	440	900
350	El. Machy.	Synch.	2300	900
300	G.E.	Slipring	220/440	514
250	G.E.	Sq. Cage	440	1200
250	Gen. Elec.	Sq. Cage	440	3600
250	Whse.	Sq. Cage	2300/440	600
250	Whse. (4)	Slipring	2300/440	600
200	Gen. Elec.	Synch.	550/440	400
200	G.E. b.b.	Sq. Cage	220/440	720
200	G.E.	Slipring	220/440	450
200	G.E.	Slipring	440	600
200	G.E.	Slipring	2200	900
200	Reliance b.b.	Sq. Cage	220/440	1800
200	Allis Ch.	Slipring	2200/440	720
200	A.C. TEFC	Sq. Cage	220/440	1200
150	Reliance b.b.	Sq. Cage	2300/440	1200
150	Whse. b.b.	Sq. Cage	440	1800
150	Cr. Wheeler	Sq. Cage	440	450
150	Whse. XP	Sq. Cage	440	3600
150	G.E. (4)	Slipring	2200/440	600
150	Whse.	Slipring	220/440	1200
125	Whse. b.b.	Sq. Cage	220/440	900
125	A.C. TEFC	Sq. Cage	220/440	1800
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125	G.E. TEFC	Sq. Cage	2200	3600
125	Al. Ch. TEFC	Sq. Cage	220/440	600
125	G.E. (2)	Slipring	220/440	514
125	G.E.	Sq. Cage	2300/440	1200
100	Allis Ch.	Slipring	2300/440	600
100	Al. Ch. TEFC	Sq. Cage	2200	1800
100	G.E. b.b.	Sq. Cage	220/440	3600
100	G.E. (2)	Slipring	220/440	1200

D. C. GENERATORS

KW	Mfr.	Type	Volts	Speed
300	Gen. Elec.	CY-221	250/350	1200
200	Gen. Elec.	RC	250	1450
100	Delco b.b.	late	120/240	1200
75	Allis Ch. b.b.	EB-146L	125	1500
60	G.E. b.b.	CD	600	1750
50	G.E. (2)	CD-1129	250	1200

D. C. MOTORS

HP	Mfr.	Type	Volts	Speed
250	Cr. Wh.	101-H	230	1150
200	G.E. (2)	RC-38	230	1150
200	Whse. b.b.	SK	250	287/575
150	Rel. TEFC b.b.	2550-F	230	850
150	Whse.	SK-210	230	320/1000
125/150	F.M. b.b.	DXZD	230	325/1200
125	G.E.	CD-173	230	575/1150
100	Elliott b.b. T.E.	JH-FE	230	1150
100	El. Dyn. b.b. (2)	30-S	230	450/1200
100	G.E. crane	CO-1831	230	675
75/100	Whse.	SK-191	230	300/900
60	G.E. TEFC b.b.	CD-135	230	1150
30/40	L.A. b.b. (2)	ONW	230	500/1500

MOTOR-GENERATOR SETS

KW	Mfr.	Input V	Output V.
600	Allis Ch.	440 AC	250 DC
300	G.E.	440 AC	250/350 DC
200	Allis Ch. (2)	440 AC	250 DC
200	Whse. synch.	220/440 AC	55 DC
200	Gen. Elec.*	220/440 AC	125 DC
125	Whse.	220/440 AC	250 DC
100	Delco b.b.	220/440 AC	120/240 DC
80	Star b.b. Synch	220/440 AC	250 DC
75	Whse. Synch.	220/440 AC	250 DC
60	Ideal	220/440 AC	125 DC
50	Whse. synch.	220/440 AC	250 DC
30	G.E. (2)	220/440 AC	125 DC
30	Whse.	220/440 AC	250 DC

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CHICAGO 7, ILLINOIS

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Wanted
TURBO GENERATOR
2500 to 3000 KW Inlet Steam Pressure 400# at 700°F FTT, Exhaust Steam Pressure 25#, 480 Volts, 3 Phase, 60 Cycle. Submit FULL specs. EXACT condition, Photos, Outline Prints, Best Price.
SUPERIOR PRODUCTS CO.
P.O. Box 357, Riverside Station, Miami 35, Fla.

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WANTED

1—2500-5000 KW TURBINE GENERATOR 400#-600# throttle, 700-750°, with surface condenser, 3-60-4160 V., with switchgear if available.

Please quote us on any other turbine-generators, condensing or non-condensing, 1500 KW or up.

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CHICAGO—Bishop 2-2458

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Installed but never used
Built of finest materials

WESTINGHOUSE 1250 K.W. TURBO-GENERATORS

(4)—Westinghouse—440/3/60—850°—540 lbs. working pressure. Complete with condensers, circulating pumps, etc.

BOILERS
7 B&W EXPRESS TYPE

Design pressure 634# — operating pressure 565# — temp. 850°F. Oil fired — separately fired superheaters. *Capacity: 210,000 lb.* steam/hr. ideal for testing where large quantities of steam are required, giving excellent control from separately fired superheaters. Can be converted for #2 oil and natural gas. Fully automatic.

LARGE DEAERATING FEED HEATERS

Monel construction — spray type — capacity 480,000 lbs./hr.—vent condenser—single pass —heating surface 174 sq. ft.—all Monel construction.

GE HIGH AND LOW PRESSURE MAIN PROPELLING TURBINES

Will sell separately for testing, wind tunnel or similar work. (2) high pressure—24,400 HP—12 impuse stages—4909 RPM—working pressure 540 lbs.—825°F. (2) low pressure—28,600 HP — 3913 RPM — working pressure 49 lbs. steam—424°F—2-6 stages of impulse.

FEED PUMPS

Ingersoll-Rand—5"—three stage—500 GPM at 750 lb. discharge. BHP 330—5000 RPM—Worthington turbine—573 lbs.—non-condensing—back pressure 20 lbs.

FORCED DRAFT BLOWERS

29,000 CFM—max. static 35"—normal 21".

LUBE OIL COOLERS

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THE BOSTON METALS CO.
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BARGAINS!

1050 HP FAIRBANKS-MORSE DIESEL MODEL 32, 7 CYL., 257 RPM, 726 KW, FM 3/60/2400 WITH EXCITER, SWITCHBOARD, ETC. VERY LOW PRICE.

3000 CFM WORTHINGTON AIR COMPRESSOR 2 STAGE, HORIZONTAL, 164 RPM, 5 STAGE CONTROL. 650 HP 3/60/440 SYNCHRONOUS MOTOR. COMPLETE ACCESSORIES.

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RE-NU-BILT ELECTRICAL EQUIPMENT

53 YEARS SERVICE

MOTOR GENERATOR SETS

Qu.	KW	MAKE	RPM	AC VOLTS	DC VOLTS
2	4800	G.E.	450	2300/4600	250/300
1	2500	WHSE.	720	2300/4160	600
1	2100/2100	G.E.	450	2300/4600	250/300
2	1750/2100	G.E.	514	2300/4600	250/300
1	2000	G.E.	514	2300/4600	600/666
1	1500	G.E.	720	13200/6600	600
1	1500	Cr. Wh.	720	2300/4160	30/100
1	1250	WHSE.	720	2300/4000	600
1	1000	G.E.	900	2300/4000	600
1	1000	G.E.	900	6600/4000	260
1	1000	G.E.	720	2300/4000	275
1	500	G.E. Unused	1200	2300	300
1	500	G.E.	900	2300/4600	250
1	500	G.E.	900	440	250/125
1	350	G.E.	900	440/4160	125
2	300	G.E.	1200	2300	275
1	300	WHSE.	1200	2300/4160	600
1	200	G.E.	1200	2300/4160	250
1	200	G.E.	1200	440	250

FREQUENCY CHANGER SETS

Qu.	KW	MAKE	FREQ.	VOLTAGES
1	12500	WHSE.	60 To 25	13200-13200
1	3000	G.E.	60/50/60	1100-6600
1	2500	G.E.	60/24/60	2400-2400

3 PHASE 60 CYCLE MOTORS

SLIP RING

	HP	MAKE	TYPE	VOLTS	SPEED
1	1750	G.E.	M-579BS	4800/2400	1800
1	800	G.E.	MT-428	2200	450
1	800	WHSE.	CW	550/2200	1776
1	600	WHSE.	CW-32D	440	1778
1	600	WHSE.	CW	440	850
1	550	WHSE.	CW	440	252
1	500	WHSE.	CW	2300	881
1	500	WHSE.	CW	550/2300	350
1	300	AL. CH.	ANY	2200	720
1	300	GEN. EL.	MTP-561	2200	1760

SQUIREL CAGE

3	1500	G.E.	K D.P.	2200	3580
1	1000	AL. CH.	ANW	2300	1180
1	550/275	WHSE.	CS-1115	2300	863/445
2	500	WHSE.	CSP-883H D.P.	440	3600
4	500	AL. CH.	ARW-D.P.	2300	3600

PUMPS — MOTOR DRIVEN

1—15000 G.P.M. Al. Ch., Type LS—Centrifugal, 20" Suc., 18" Disch., 117 ft. discharge head, with suction 5 ft., Bronze fitted — coupled 500 HP, ANYW-D.P., Wound Rotor Motor, 2300-3-60-880 RPM—Complete Controls.

1—15000 G.P.M. Al. Ch., Type SF-Centrifugal, 18" Suction, 16" Disch., 285 ft. discharge head, with suction head 70 ft., total disch. head 216 ft.,-coupled 1000 HP ANY, D.P., Sq. Cage, 2300-3-60-1180 RPM—Complete Magnetic Reatcor Control

Above 2 Pumps—still installed—practically New—in Water Works Stations

6—600 G.P.M. Gould, Figure 3360, 8 Stage, 2310 Ft. Head, 1000#, 3550 RPM, Each coupled to 500 HP 3-60-3550 RPM D.P. Sq. Cage Motor

2—WHSE, Type CSP-583H, 440 volt

4—Allis Type 2300 volt Magnetic Encl. Reduced Voltage Starters

BELYEA COMPANY, INC.

43 Howell St., Jersey City 6, N. J.

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"For BIGGER SAVINGS and BETTER SERVICE, Get Our BARGAIN PRICES on Guaranteed NEW and REBUILT MOTORS"

SQUIRREL CAGE MOTORS NEW AND GUARANTEED

HP	Make	REBUILT Type	Speed
500	G.E. S.B. Open	IK	1200
400	West. B.B. Drip	CSP-681	1800
400	L.A. B.B. Splash		1800
400	G.E. S.B. Open	IK	1200
400	West S.B. Open	CS	900
350	West. B.B. Drip	CS-22556H	1200
300	L.A. B.B. Splash	FX-146S	1800
300	G.E. S.B. Open	IK	1800
300	Reliance B.B. Drip	AA-6085	1200
300	G.E. S.B. Open	IK	900
300	Cont. B.B. Splash	N-804	900
300	G.E. S.B. Open	IK	720
300	G.E. S.B. Open	KT-561	720
300	G.E. S.B. Open	IK	600
250	G.E. S.B. Open	KT	1800
250	West. B.B. Splash	CS-875	1800
250	G.E. S.B. Open	IK	1200
250	G.E. S.B. Open	IK	900
250	G.E. S.B. Open	IK	720
200	G.E. B.B. Drip	K-6325	1800
200	West. S.S.B. Open	CS-855	1800
200	Cont. TEFCBB	NF-743X	1200
200	West. S.B. Open	CS	1200
200	G.E. S.B. Open	IK-15	1200
200	G.E. S.B. Open	IK-158	1200
200	G.E. S.B. Open 2200 v.	IK	1200
200	G.E. S.B. Open	IK	900
200	A.C. B.B. Open	AR-826	1200
150	West. TEFCBB	CS-8120S	1800
150	G.E. S.B. Drip	K-6324	1800
150	West. S.S.B. Open	CS-771-C	1800
150	Al. Chal. B.B. Open	AR	1800
150	West. S.B. Open 2200V	CS	1800
150	L.A. B.B. Open	115	1200
150	West B.B. Splash	CS-580	1200
150	West. B.B. Drip	CS-772	1200
150	West. TEFCBB	CS-775	1200
150	G.E. B.B. Open	KT	1200
150	G.E. B.B. Open	KT-557	1200
150	Al. Chal. B.B. Open	AR-820	900
150	Cont. TEFCBB	N-743-X	900
150	Al. Chal. TEFCBB	AZ	900
150	F.M. B.B. Open	H-24A	900
150	G.E. S.B. Open	IK	900
150	G.E. S.B. Open	IK	720
125	G.E. TEFCBB	K	$600
125	Burke B.B. Open 440 Volt	N-505	$600
125	Reliance T.E.F.C. B.B.	AA-5084	1800
125	G.E. S.B. Open	IK	1800
125	G.E. B.B. Splash	W-585	1800
125	Al. Chal. B.B. Open	AR	1800
125	G.E. S.B. Open	K1-553	1200
125	Century B.B. Drip		1200
125	G.E. B.B. Open	IK	1200
125	Ideal B.B. Open	A-585	1200
125	F.M. B.B. Open	H	900
125	G.E. S.B. Open	IK	720
125	G.E. S.B. Open	IK	600
100	Al. Chal. T.E.F.C. B.B.	ARZ-823	3600
100	C.W. B.B. Open 2300 Volt	SC-445	3600
100	Reliance T.E.F.C.B.B. New	AA-445U	1800
100	G.E. S.B. Open	KT-343	1800
100	G.E. B.B. Open	K-504	1800
100	Cont. TEFCBB XP	NP-505	1800
100	Al. Chal. B.B. Drip	ARW-823	1800
100	G.E. S.B. Open	KT-347	1200
100	Ideal B.B. Drip New	A-584	1200
100	West. B.B. Open	CS-607	1200
100	West. S.S.B. Open	CS-754-C	900
100	Al. Chal. T.E.F.C. B.B. XP	23E8	900
100	F.M. B.B. Open	H20C	900
100	Al. Chal. B.B. Open	AR-823	900
100	F.M. B.B. Open	H	720
100	F.M. B.B. Open	H	600
75	G.E. B.B. Open	K-505	1200

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Motors, Control Equipment, AC and DC Generators, MG sets and transformers.

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BOILERS (Package type)

B&W—60,000 lbs./hr.—475 psig., 740°TTL, oil fired (shipped intact as one integral unit)
B&W—122,500 lbs./hr.—635 psig., 850°TTF, oil fired (unassembled)
B&W—153,600 lbs./hr.—634 psig., 850°TTF, oil fired (unassembled)

TURBOGENERATORS

4600 KW GE Turbine—Gen Set, Cond 410psi, 725°TTF, 28.5 Hg exh, 3/93.3/2700V PF 1.0—New
1800 KW GE Turbine—Gen Set, Cond 410psi, 725°TTF, 28.5 Hg exh, 3/60/1735 V PF .08—New
1500 KW Westinghouse—Gen Set, Non Cond 400psi, 3/60/480V PF .08
1000 KW Westinghouse Turbine Gen. Set. Non. Cond. 190psi, 600°TTF, 3/60/480V/3600RPM
600 KW GE Turbine-Gen Set, Cond. 525/450psi, 850TTF 1" abs. exh 3/60/450V/1200RPM

STEAM TURBINES

1000 SHP GE Cruising Cross Compound, 525psi, 825°TTF, 81psi exh, 10,119/350 RPM with Falk reduction gears—New
3000 SHP GE HP Main propulsion turbine 410psi, 9040RPM, 725°TTF } 1 Set—New
3000 SHP GE—LP Main propulsion turbine 40psi, 9040RPM }
11.50 SHP GE HP 12 Stage Cross compound turbine 525 psig, 825°TTF 5870RPM } 1 Set—New
13,450 SHP GE LP 48psig, 4714RPM with Westgh speed decreaser gear assy. }
294 HP Worthington-Moore, Non-Cond. Form #S2R, 310psig, 650°TTF, 2psi-exh, 3560RPM
250 HP Sturtevant non-condensing Turbine—575psi, New

PUMPS, CENTRIFUGAL (Motor driven)

263 GPM @ 375'TDH, Ingersoll Rand—2GT, w/60HP 3525RPM 3/60/440V (Used)
275 GPM @635'TDH, Ingersoll Rand—2GT, w/75HP 3525RPM 2/60/2300V (Used)
1000 GPM @ 8"x6" Ingersoll Rand w/40HP 3/60/208V (Used)

PUMPS, CENTRIFUGAL (Turbine driven)

460 GPM @ 750psi discharge, Worthington, w/350HP turbine, 575 psi, 4900RPM—New

BLOWERS, TURBO-CENTRIFUGAL

20,000 CFM @ 17"WC, Westinghouse, Vaneaxial, w/Turbine, 82.5HP, 375psi, 10psi—exh. 4625 RPM—New
24,000 CFM @ 26"WC, Sturtevant Co, Rexvane, w/Turbine, 191HP, 400 psi, 10psi—exh. 3525RPM—New
31,250/24,000 CFM @ 45"/28" W.C. Sturtevant Propeller-Fan w/162HP, 575psi, 15psi exh, 5850/4600RPM

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38 Years Dependable Service

SLIP RING MOTORS 3 Ph., 60 Cy.

H.P.	Volts	Make	Speed
500	4000/2300	G.E.	600
450	4000/2300	G.E.	1200
400	2300/440	G.E.	600
400	4000/2300	Whse.	720
300	4000/2300	G.E.	720
300	440	Whse.	3600
250	4000/2300	Al. Ch.	600
200	2300	G.E.	600
200	2200/440	G.E.	720
150	440/220	G.E.	1800
150	2200/440	Whse.	720
125	2300	G.E.	600

AC GENERATORS or SYN MOTORS, 60 Cy.

H.P.	Volts	Make	Type	R.P.M.
400	2300	G.E.	TS	1800
400	2200/440	G.E.	ATI	720
300	2200/440	G.E.	TS	1200
300	440	G.E.	TS	720
150	440/220	Whse.	G	1200
125	440/220	Whse.	HR	400

SQUIRREL CAGE MOTORS

500	2200/4000	Elliott	SC	1800
400	2300	G.E.	PT	3600
400	2300/4000	G.E.	K	1200
350	2300/4000	G.E.	SEDP	3600
350	2300/4000	G.E.	K	600
300(2)	2300	G.E.	PT	3600
300	2300/4000	L. Allis	FS	1800
300	2300/400	G.E.	KT	600
250	2300/4000	G.E.	K	720
250	2300/440	G.E.	K	1200
200	2200	G.E.	KT	1800
200	2200	Cont.	TEFC	3600
150	440	Whse.	X-pf.	3600
150	440/220	Cont'l.	X-pf.	1800
150	440/220	G.E.	TEFC	720
150	2200/440	G.E.	TEFC	3600
125	2200/440	G.E.	PT	1200
100	440	Whse.	TEFC	3600
100	440	Cont.	X-pf.	1800
100	2200	G.E.	PT	900
100	440	Al. Ch.	Spl-Pf.	900

CIRCUIT BREAKERS, 3 Pole

2—1600 Amp., G.E., AL-50, 600 V., Air
1—1600 Amp., G.E., AL-50, 600 V., outdoor
1—1200 Amp., Whse., F-124, 7.5 KV, manual
1—600 Amp., G.E., 15 KV, Sol. oper.
1— 600 Amp., Whse., 7.5 KV, outdoor, New.

D. C MOTORS

H.P.	Volts	Make	Type	Speed
150	230	El. Dyn.	B/brg.	800
90	230	G.E.	CD	1750
50	230	G.E.(4)	CD	1150

MOTOR GENERATOR SETS

KW	Make	Input., AC	Motor Type	Output V., DC
300	Whse.	4150/400	Syn.	250/125
150	G.E.	440/220	Syn.	250
125	G.E.	440/220	Sq. Ca.	125
100	G.E.	2200/440	Syn.	250
65	G.E. B	2200/440	Sq. Ca.	250

TRANSFORMERS 60 Cy.

3—500 kva, Whse., 4160-240 V., 3 ph., Inertven
3—500 kva, G.E., 13,800—340/480 V.
3—200 kva, Mol., 13,800—2300 V.
3—333 kva, G.E., 13,800—2400 V.
3—333 kva, G.E., 2400—240/120 V.
3—333 kva, Whse., 2400/4160Y—240/480 V.
1—300 kva, Whse., 4160—480 V., Dry, New
3—250 kva, Whse., 2100/4160Y—240/480 V.
3—200 kva, G.E., 2400—460V. Pyr.
3—200 kva, G.E., 13,800—480 V.
3—200 kva, G.E., 4156—480/240 V.
3—167 kva, Whse., 4156—480 V.
3—150 kva, Al. Ch., 2400—220 V.
3—150 kva, G.E., 13,200—2300 V.
1—150 kva, Whse., 4160—120/208Y V., 3 ph. Dry New
3—100 kva, Whse., 2400—240/480 V., Dry
3—100 kva, G.E. 2400—120/240 V., Pyr.

only partial listing

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HARRY J. RICE, Pres.
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3—2500 KVA G-E 6900—2400/4160Y
3—2500 KVA G-E 6900—7200/12470Y
4—2500 KVA W-H 34500—2400/4800/11000
3—1500 KVA G-E 69000—2400/4160Y
3—1500 KVA G-E 69000—7200/12470Y
3—1000 KVA G-E 34500—7200/12470Y
3— 833 KVA W-H 43800—480

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"America's Exclusive Independent Transformer Service Shop"

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No better values at any price

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138 CFM 100 PSI 7x7, Ing. ES, CP & Joy
288 CFM 100 PSI 9x9 Ing. Worth. CP
321 CFM 125 PSI 10x11 Ch. Pn. T
351 CFM 350 PSI 11-5x11 CP TCB-2
364 CFM 100 PSI 10x9 Joy WG9
465 CFM 100 PSI 12x11-1R-ES-1" Chic. P.T.
502 CFM 125 PSI 12x13 Worth HB
593 CFM 125 PSI 13½-8½x8 Worth DC2
686 CFM 100 PSI 14x13 Ing. ES
800 CFM 100 PSI 14¼-9x7 Ing XLE
125 HP Syn. 3-60-2300
877 CFM 125 PSI 17-10½x14 IR, XRB-CV
1665 CFM 100 PSI Fuller—C-300-300H
300 HP Syn 3-60-440 .8 PF
2520 CFM 125 PSI 17-10¾x8 Clark. CMA4L
350 HP 3-60-2300 (1954)

AMERICAN AIR COMPRESSOR CORP.
48th & P, North Bergen, N.J. UN 5-1397

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MODERN POWER BOILERS

1—Babcock & Wilcox	—122,000#s/hr	—250 psi
3—Combustion-Engineering	—110,000	—200 psi
1—Riley	—100,000	—456 psi
1—Babcock & Wilcox	—100,000	—450 psi
1—Babcock & Wilcox	— 90,000	—263 psi
1—Combustion-Engineering	— 75,000	—250 psi
1—Riley	— 70,000	—250 psi
2—Babcock & Wilcox	— 70,000	—450 psi
1—Riley	— 60,000	—290 psi
2—Combustion-Engineering	— 50,000	—250 psi
1—Babcock & Wilcox	— 45,000	—450 psi
1—Combustion-Engineering	— 40,000	—220 psi
1—Foster-Wheeler	— 40,000	—200 psi
1—Babcock & Wilcox	— 35,000	—300 psi
2—Riley	— 35,000	—250 psi
1—Babcock & Wilcox	— 27,500	—450 psi
2—Riley	— 19,000	—200 psi

MIDWEST BOILER & TURBINE CO.
WARNER NEW HAMPSHIRE PHONE 244

Circle 523 on Reader Service Card

FOR SALE

1500 KW, 80% Power Factor, 3 phase, 60 cycle, 2300 volts, 3600 RPM, General Electric 5-stage noncondensing steam turbine generator unit, 375 PSIG, 700° FTT, 125# exhaust back pressure, complete with direct connected shaft exciter and switchgear. Excellent condition—available immediate delivery.

EUCLID ENGINEERING CORPORATION
909 National City East Sixth Building
Cleveland 14, Ohio

Circle 522 on Reader Service Card

3—G.E. 1000 KVA transformers, 1Ø, 13800-460 V.
1—Otis elec. freight elevator, 5000# @ 75 FPM.
3—Wagner 500 KVA transformers, single phase, 66000-460 volt.
1—Raymond 50" 5-roller hi-side mill, dbl. whizzer separator.
1—Babcock & Wilcox #32E coal pulverizer, airswept, 75 Hr.
2—E. Keeler 200 HP water-tube boilers, 160 PSI, Stoker-fired.
1—Gardner-Denver air comp., 445 cpm @ 100#, 6 cyl., 2 stage.

PERRY EQUIP. CORP.
1422 N. Sixth St.
Philadelphia 22, Pa.
POplar 3-3505

Circle 524 on Reader Service Card

DIESEL ENGINES

1 HEAVY DUTY NORDBERG

Type TSM—model 32118—1700 HP @ 180 RPM — 21½" x 29". Unit complete with all pumps and coolers. Can be used for generator drive, producing 2400 HP @ 225 RPM. Equal to new. Presently in Maritime Academy.

1 UNUSED G.M. 12-278A

1200 HP — 8¾" x 10¼" — 12 cylinder — VEE type — 2 cycle — 750 RPM — left hand — serial 50428. Excellent unused and fully guaranteed late type engine.

THE BOSTON METALS CO.
313 E. Baltimore St., Baltimore 2, Md.
ELGIN 5-5050 — LEXINGTON 9-1900

Circle 525 on Reader Service Card

POWER EQUIPMENT

15000 KW, NEW, Cond. Turbo-Generator 3/60, 13800 V, 3600 RPM, 850 PSIG, 900°TT with boiler.
1000 KW, G.E., Non C. Turbo-Gen. 3/60, 2300 V, 3600 RPM 400 PSIG 600°TT, 90-125 PSIG Exh.
300 KW, .60 PF, G.E. Cond. Turbo-Gen 3/60, 2300 V. 5917/1200 RPM, 400 PSIG, 600°TT, geared.
1000 KW, G.M. 16-278A, Diesel Units (2) 3 ph. 60 cycle, 2300 V, 720 RPM
300 KW, G.M. 8-268A, Diesel Units (2) 3 ph. 60 cycle, 480 V, 1200 RPM
500 KW, .8 PF, West. 3/60, 240/480 V 300 RPM, Gen. direct conn. to Ames Vertical Uniflow Engine.

BREW, WOLTMAN
& COMPANY, INC.
50 CHURCH ST., N.Y. 7, N.Y.

Circle 526 on Reader Service Card

SEARCHLIGHT EQUIPMENT Locating Service

No Charge or Obligation

This service is aimed at helping you, the reader of "SEARCHLIGHT", to locate Surplus new and used Power Equipment not currently advertised. (This service is for USER-BUYERS only.) How to use: Check the dealer ads to see if what you want is not currently advertised. If not, send us the specifications of the equipment wanted on the coupon below, or on your own company letterhead to:

Searchlight Section Locating Service
c/o POWER
330 W. 42nd St., N. Y. 36, N .Y.

Your requirements will be brought promptly to the attention of equipment dealers advertising in this section. You will receive replies directly from them.

Searchlight Section Locating Service
c/o POWER
330 W. 42nd St., N. Y. 36, N. Y.

Please help us locate the following equipment components.

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NAME .....

TITLE .....

COMPANY .....

STREET .....

CITY 2/61

MOTOR GENERATOR SETS

Q	KW	MAKE	D.C.	A.C.	RPM
2	750	G.E.	250	3/60	720
1	500	Elliott	125	3/60	720
2	300	G.E.	250	3/60	1200
1	150	West.	250	3/60	1200
1	100	Star	250	3/60	1200

STEAM- TURBO- GENERATORS 3/60

Q	KW	MAKE	TYPE	I.S.P.	YEAR
1	10000	West.	Cond.	275	1932
1	7500	G.E.	Cond.	275	1948
2	7500	West.	Cond.	400	1945
1	5000	West.	Cond.	100	1938
1	5000	West.	N. Cond.	850	1941
1	3000	G.E.	Cond.	400	1940
1	2500	G.E.	N. Cond.	180	—
1	2000	G.E.	N. Cond.	180	—
1	1000	Elliott	N. Cond.	325	1930
2	1000	Elliott	Cond.	150	1940
2	300	G.E.	Cond.	400	1945

PACKAGE BOILERS

Q	HP	MAKE	W.P.	FIRING	YEAR
1	400	Cl. Bk	150	#6	1948
1	400	T'Ville	150	#6	1948
1	200	Erie	160	#6	1951
1	150	Cyclotherm	150	#6	1947
1	150	Cl. Bk	15	#6	1956
1	90	Cyclotherm	125	#2	1945
1	80	Cl. Bk	125	#6	1948
1	70	Ames	15	#2	1951
1	60	Cyclotherm	125	#2	1945

DIESEL GENERATOR SETS

Q	KW	MAKE	VOLTS	RPM
2	2000	Baldwin	230V.D.C.	257
2	1122	F.M.	460V.D.C.	720
2	1000	G.M.	3/60/2400	720
1	620	Alco	240V.D.C.	700
1	400	Worth.	3/60/480	600
1	300	G.M.	3/60/220-440	1200
2	125	Worth.	3/60/480	600

AIR COMPRESSORS

CFM	PSI	MAKE	TYPE	H.P.	VOLTAGE	RPM	YEAR
7550 (2)	24/30	I.R.	XHE	600	3/60/4160	300	1948
6000	125	Sullivan	H	1250	3/60/2300	200	1943
1853	125	Worth.	DC-2	300	3/60/2300	277	1946
1530	125	Worth.	OXP	250	Steam	200	1943
1308	125	C.P.	OCE	225	3/60/440	257	1937
1300	125	I.R.	XRE	225	3/60/440	257	1940
570	125	Gardner	WBK	150	3/60/440	870	1951
515 (4)	125	I.R.		40	3/60/440	870	1940/50
500	125	I.R.	K500		Diesel Portable		1948
494	125	I.R.	XRB	75	3/60	277	—
464	100	I.R.	ES-1	75	3/60	300	1950
368	100	I.R.	ER-1	60	3/60	277	Late
250	2500	Worth.	3 stg.	175	3/440	257	Late
218	200	I.R.	40	50	3/60	870	Late
211	100	I.R.	E.S.	40	3/60	325	1948
174	125	Worth.	H	30	3/60	300	1940
173	100	I.R.	E.R.	30	3/60	300	1945
78	350	I.R.	ES-2	20	3/60	350	1954
8.8	2500	I.R.	ES-2	20	3/60	350	1945

"Everything from a Pulley to a Powerhouse"

THE O'BRIEN MACHINERY CO.

T. M. REGISTERED U. S. PATENT OFFICE

• Telephone BAldwin 8-1480
• Cable Address OBRIEN PHILA.

MERCHANTS—CONSULTING ENGINEERS—EXPORTERS

"OFFICES IN MEXICO, BRAZIL, COLUMBIA, ARGENTINA, PANAMA" Se Habla Espanól

1937 W. CLEARFIELD ST., PHILADELPHIA 32, PA.

Circle 527 on Reader Service Card

DIESEL GENERATOR SETS

(4) NEW 500 KW GM 8-278

Engines — 715 HP — Vee type — 8 cylinder — 8½ x 10½ — air starting — 720 RPM — 2 cycle — heat exchanger cooled. Engines drive 500 KW Allis-Chalmers D.C. generators—120/240 — 2080 amps — 720 RPM — compound wound. Complete with a very generous supply of spare parts. IF YOU NEED D.C. POWER, NOTHING CAN BEAT THIS VALUE. FULLY GUARANTEED.

NOTE:

We can also quote you using the above engine — radiator cooled and with an A.C. generator — either 440/2300 or 4100 — and offer a completely portable unit.

EXCELLENT GENERATORS FOR STANDBY POWER

(1) UNUSED 250 KW UNIT

440/3/60 — 900 RPM Westinghouse generator — driven by a Cooper-Bessemer 8¾ x 11 engine model F.S.6 — Heat exchanger cooled. This is an unused set in prime condition. Will demonstrate. Unit is a slow-speed heavy duty diesel generator.

(4) AS ABOVE, RECONDITIONED

With Switchgear

Send us your inquiries

THE BOSTON METALS CO.

313 E. Baltimore St., Baltimore 2, Md.
ELGIN 5-5050 LEXINGTON 9-1900

Circle 528 on Reader Service Card

FEATURED ITEMS

BOILERS

44500 #/hr CE 450 PSI @ 750°F NEW
35000 #/hr CE 285 PSI @ 577°F NEW
18000 #/hr Keeler CP 160 PSI
620 #/hr Cyclotherm 250 PSI

AIR COMPRESSORS

6700 CFM @ 125 PSI Sullivan 1250 HP
1360 CFM @ 35 PSI Worthington YO 150 HP
800 CFM @ 100 PSI Ing. Rand XLE 14½ & 9x7
387 CFM @ 100 PSI Ing Rand Type 40 75 HP
142 CFM @ 100 PSI Ing Rand Type 40 25 HP

TRANSFORMERS

2000 KVA Al. Ch. 33000—2400 3/60—(2)
2000 KVA West. 13800—2400 1/60—(4)
500 KVA Al. Ch. 2400—480 3/60—(2)
500 KVA West. 2300—440 1/60—(3)
500 KVA Wagner 66000—480 1/60—(3)
200 KVA West. 2300—230/460 1/60 (3)
6000 KVA 44000—4160 3/60 Substation

MOTOR GENERATOR SETS

750 KW Cr. Wh. 3/60/2200/720 RPM—250 V DC
750 KW G.E. 3/60/2200/900 RPM—250 V DC

NATURAL GAS ENGINE GENERATORS
(Can be seen running)
1250 KVA Rathburn Jones—3/60/2400-4160

MOTORS—Class I Group D

350 HP Al. Ch. 3/60/2300/450 RPM
350 HP Al. Ch. 3/60/2300/3600 RPM
250 HP Cont. 3/60/2300/720 RPM
250 HP Al. Ch. 3/60/2300/3600 RPM
250 HP G.E. 3/60/2300/3600 RPM
200 HP G.E. 3/60/2300/3600 RPM
150 HP Al. Ch. 3/60/2300/3600 RPM

TURBO GENERATOR SETS

1250 KVA G.E. 3/60/2300/3600 Cond. 200 PSI
540 KW West. any Voltage—Cond. 200 PSI
1875 KVA Surface Cond. 400 PSI, 700°FTT

HEAT & POWER CO. INC.

60 East 42nd St., New York 17, N.Y.
310 Thompson Bldg., Tulsa 3, Okla.

Circle 530 on Reader Service Card

TRANSFORMERS—60 CYCLE

QU.	KVA	MAKE	TYPE	PHASE	VOLTAGE
2	3000	Moloney	TCR	3	7200-4160/2400
2	3000	G.E.	OA-T	3	26,400-4160/2400
1	1500/1750	West.	O.I.S.C.	3	tns. hi-lo 26,400-480 taps-hi
3	333	G.E.	HS-WR	1	2400/4160Y-240/480
1	300	Penna.	OA Askarel	3	12,470Y/7200-240
3	200	Amer.	C.C.	1	4160/7200-240/480
3	200	G.E.	HS-W2S	1	2400/4160-240/480
3	100	Wagner	HE	1	2300/4160-220/440
3	75	G.E.	H-form KF1	1	2400/4160Y-120/240
3	50	G.E.	H-form K 1	1	2400/4160Y-220/440
3	50	Niagara	Dry-air	1	2400/4160Y-120/240
3	50	Harrison	Dry-air	1	2400/4160Y-220/440
3	50	Amer.WF	Dry-air	1	460/230-230/115

MOTOR GEN. SETS

QU.	KW	MAKE	SPEED	D.C.	A.C.
1	1000	West.	720	600	2300/4160 syn.
1	400	West.	1200	250/125	3 unit 4160 V. syn.
1	300	G.E.	1200	250	2300/4160 S.R.
1	300	Al. Ch.	1200	125/250	3 unit 440 syn.
1	175	West.	1200	125	4160 syn.
1	100	West.	900	230	4160 syn.

D.C. MOTORS — 230 VOLT

QU.	HP	MAKE	SPEED	TYPE
1	350	G.E.	1200	ped. type
1	30	West.	1750	SK-113
1	30	G.E.	2200	CD-85

SLIP RING MOTORS

QU.	HP	MAKE	SPEED	TYPE	VOLTS
1	500	G.E.	1200	M369Z	2200/4160
1	500	G.E.	450	MT 422Y	2200
1	450	West.	1800	CW 4-30-9	220
1	350	West.	1800	CW	2300
1	300	G.E.	1170	1-15 A	4150
1	200	West.	585	CW	440
3	150	Al. Ch.	1760	AY-RW	2300
2	150	G.E.	590	1-16	4000
1	100	West.	1770	TEFC B.B.	220/440
1	75	West.	1160	CW 607	220/440
1	75	West.	600	CW 774C	220
1	50	G.E.	570	MT 552	220/440

SQUIRREL CAGE MOTORS—3 phase—60 cyc.

QU.	HP	MAKE	SPEED	TYPE	VOLTS
1	300	Al. Ch.	1200	ARW	2200
1	275	G.E.	1180	KT 559BS	2200
2	250	G.E.	1790	KTEFC B.B.	2300
2	150	G.E.	1780	K 6325-S XP B.B.	440
2	100	Cont.	3570	NP 585-S XP B.B.	440
1	100	West.	1185	CSP 5808 B.B. drip	440/220
1	75	Cont.	3565	NP5058X XP B.B.	440
1	75	G.E.	875	KT 552Y	440
1	50	G.E.	3530	KF 405Y Vert.	220/440
1	50	Cont.	3530	NP 445X XP B.B.	220/440
1	50	Cont.	1775	NP 445X XP B.B.	440

MOTORS—SYNCHRONOUS 3 ph, 60 cyc.

HP	SPEED	MAKE	TYPE	VOLTS
325	900	West.		2300
400	450	West.	HB	440
300	720	El. Mh.	TEFC	2300
200/100	720/360	West.		4150
150	3600	G.E.	TS 956Y drip	2300
150	1800	G.E.	TS	220/440
150	900	West.		220/440
125	900	G.E.	TS 7536	2200
125	600	G.E.	TS 7641	2200
75	1200	Cr. Wh.	ALT B.B.	220/440

"FOR POWER"
J.L. HEMPHILL & CO.
1603 54th STREET, NORTH BERGEN, N. J.
PHONE NEW YORK—LONGACRE 5-3727
PHONE NEW JERSEY—UNION 3-2600

Circle 532 on Reader Service Card

THREE TURBINE GENERATOR UNITS

One—1500 KW, Elliott Turbine, 250 psig, 525 F.T.T., 5000 RPM condensing, non-extraction, geared to 1875 KVA, 2400 volt, 3 phase, 60 cps, 1200 RPM generator.

Two—750 KW, Worthington-Moore Turbine, 250 psig, 525 F.T.T., 3600 RPM, condensing, non-extraction, direct-coupled to 937 KVA, 2400 volt, 3 phase, 60 cps generator.

Both complete with most auxiliaries; for further information write:

K. H. Oliver, Purchasing Agent
Interlake Iron Corporation
1900 Union Commerce Building
Cleveland 14, Ohio

Circle 529 on Reader Service Card

FOR SALE

1050 KVA DIESEL UNIT

1050 KVA Nordberg supercharged diesel engine generator unit, 3 phase, 60 cycle 2400 volts, 327 RPM.

New 1947 — Excellent condition.

The above unit is still installed and complete with all auxiliaries as in operation. Can be adapted for dual fuel operation.

International Power Machinery Co.
1612 Union Commerce Bldg.—MAin 1-9514
Cleveland 14, Ohio

Circle 531 on Reader Service Card

UNUSED

1000 KW Turbine Generator
NON Condensing

SEACOAST EQUIPMENT CORP.
Box 4844 Normandy Miami Beach, Fla.

Circle 533 on Reader Service Card

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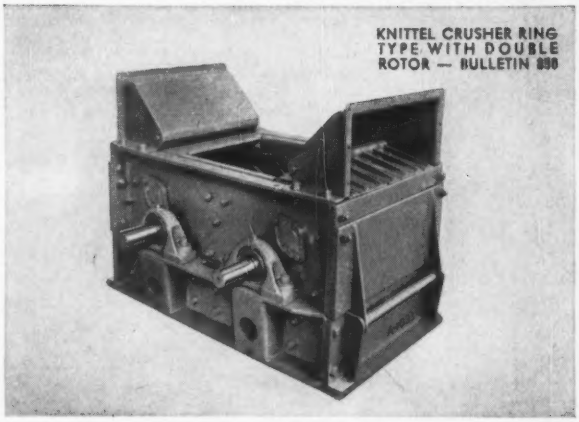
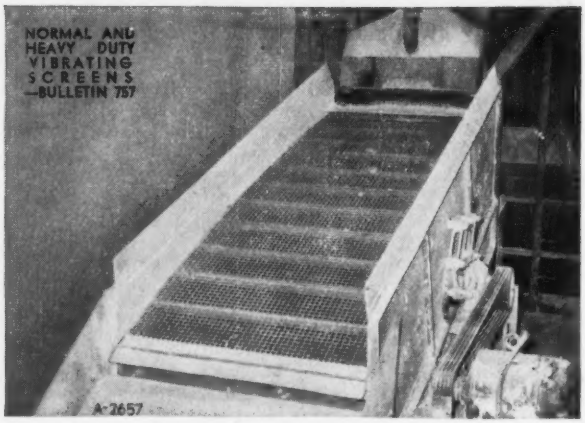
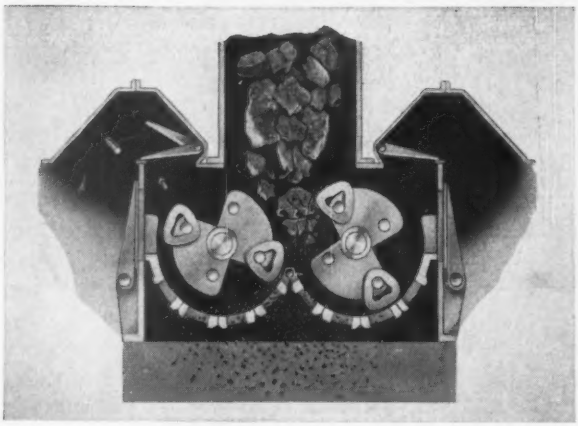
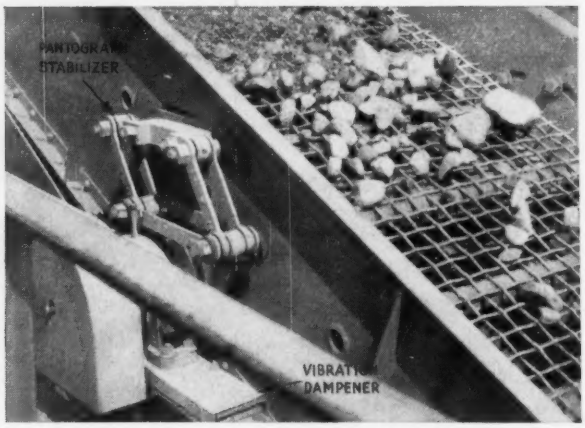

KNITTEL CRUSHER RING TYPE WITH DOUBLE ROTOR — BULLETIN 830


NORMAL AND HEAVY DUTY VIBRATING SCREENS —BULLETIN 757

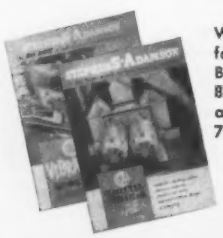
A-2657

PROVIDES MAXIMUM EFFICIENCY IN CRUSHING AND SCREENING OPERATIONS





- **EXCLUSIVE CRUSHING ACTION** . . . Permits the material to fall further into crusher where two sets of triangular sectors can take a high velocity direct blow on the suspended lumps. Three wearing surfaces of manganese steel triangular sectors automatically position themselves to present the least worn surface to the crushing action. Lumps are not only shattered but are literally gobbled up in a continuous flowing stream to the sizing grates. These sizing bars provide accurate sizing of materials preventing uncrushable material from passing.
- **CRUSHES DAMP MATERIALS with FULL CAPACITY** . . . eliminates stationary breaker plates . . . no plugging or choking . . . maintains full capacity. Automatic tramp iron release with steel fingers automatically lift to pass uncrushable material!
- **LESS HEADROOM - LESS POWER REQUIRED** . . . requires less headroom and less power than with single rotor machines.
- **EXCLUSIVE CIRCULAR MOTION AND COUNTER FLOW ACTION** . . . provide high capacity and accurate screening. Material particles pass over screen openings in every conceivable position before being discharged as oversize.
- **VIBRATION** . . . produced by the rotation of an eccentric shaft on which balance weights are mounted. The shaft is provided with self-aligning and roller bearings.
- **HEAVY DUTY CONSTRUCTION and REVERSIBLE SCREEN PANELS** . . . strong screen body is adjustable for maximum flexibility and life. S-A Vibrating Screen design provides for continuous handling of tons of material with consistent dependability.



Write for Bulletins 858 and 757

S-A
ENGINEERED BULK HANDLING SYSTEMS
MATERIALS HANDLING PRODUCTS
SPEEDWALK® PASSENGER CONVEYORS
SEALMASTER™ BALL BEARING UNITS
SPHERICO® BEARINGS & ROD ENDS

ENGINEERING DIVISION

STEPHENS-ADAMSON MFG. CO.

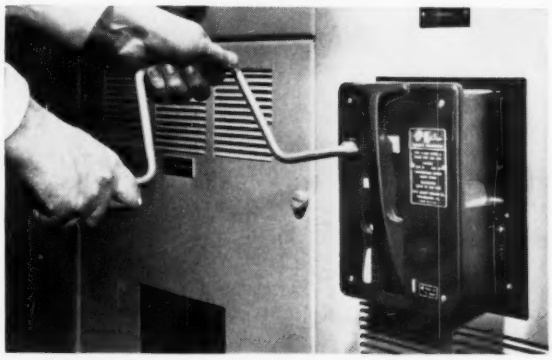
GENERAL OFFICE & MAIN PLANT, 5 RIDGEWAY AVE., AURORA, ILL.

PLANTS LOCATED IN: LOS ANGELES, CALIF. • CLARKSDALE, MISS.
BELLEVILLE, ONT. • MEXICO CITY, D. F.

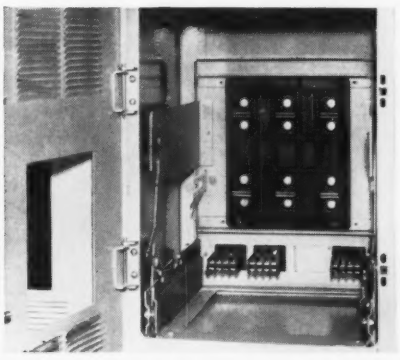
For more facts circle 321 on Reader Service card, p 103

STILL THE MOST ADVANCED 600 VOLT SWITCHGEAR!

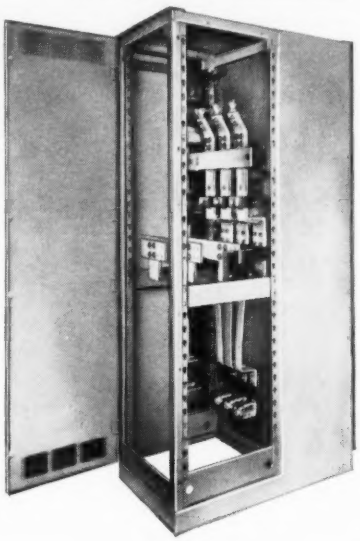
Four years ago, I-T-E introduced its completely new design advanced 600 volt switchgear with K-Line circuit breakers. In all this time right up to the present, no other gear modified or redesigned has been able to match it. Here still is today's most advanced gear, with easier operation, simpler upkeep, longer life, higher safety, and greater assurance of dependability than any other. Compare for yourself. For detailed literature, write I-T-E Circuit Breaker Co., Dept. SW, 1900 Hamilton St., Phila. 30, Pa.



Dependable drawout mechanism. Sturdy crank drive moves breaker on nonfriction rollers. Won't let you down when you need it most. Breaker can be padlocked in connected, test or disconnected positions. Door always remains completely closed for unequaled protection against dust contamination.

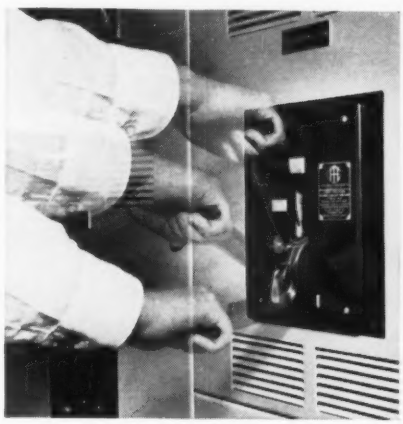


Complete isolation of breaker compartments. Each breaker is completely surrounded by solid steel barriers between it and other breaker compartments. No risk of arc gases contaminating an adjacent breaker through openings in partitions. Note also that secondary disconnects are located at the bottom of the compartment, safely removed from arc gases.



Silverplated bus. You pay no premium for this feature in I-T-E 600 volt switchgear. Aluminum bus is silverplated over its entire length for maximum conductivity. Reduces the required mass of the bus for a given maximum current. Bus is rigidly braced against movement in any direction from short circuits.

Easy-to-operate stored energy closing. Just pull down the handle, slow or fast as you please. Contacts close firmly in only 5 cycles for fast, uniform closure every time. Pulldown handle means easy operation of all breakers—top row, bottom row, or in the middle. Electrical closing mechanism, available optionally, uses a low current motor, not a solenoid.



I-T-E CIRCUIT BREAKER COMPANY

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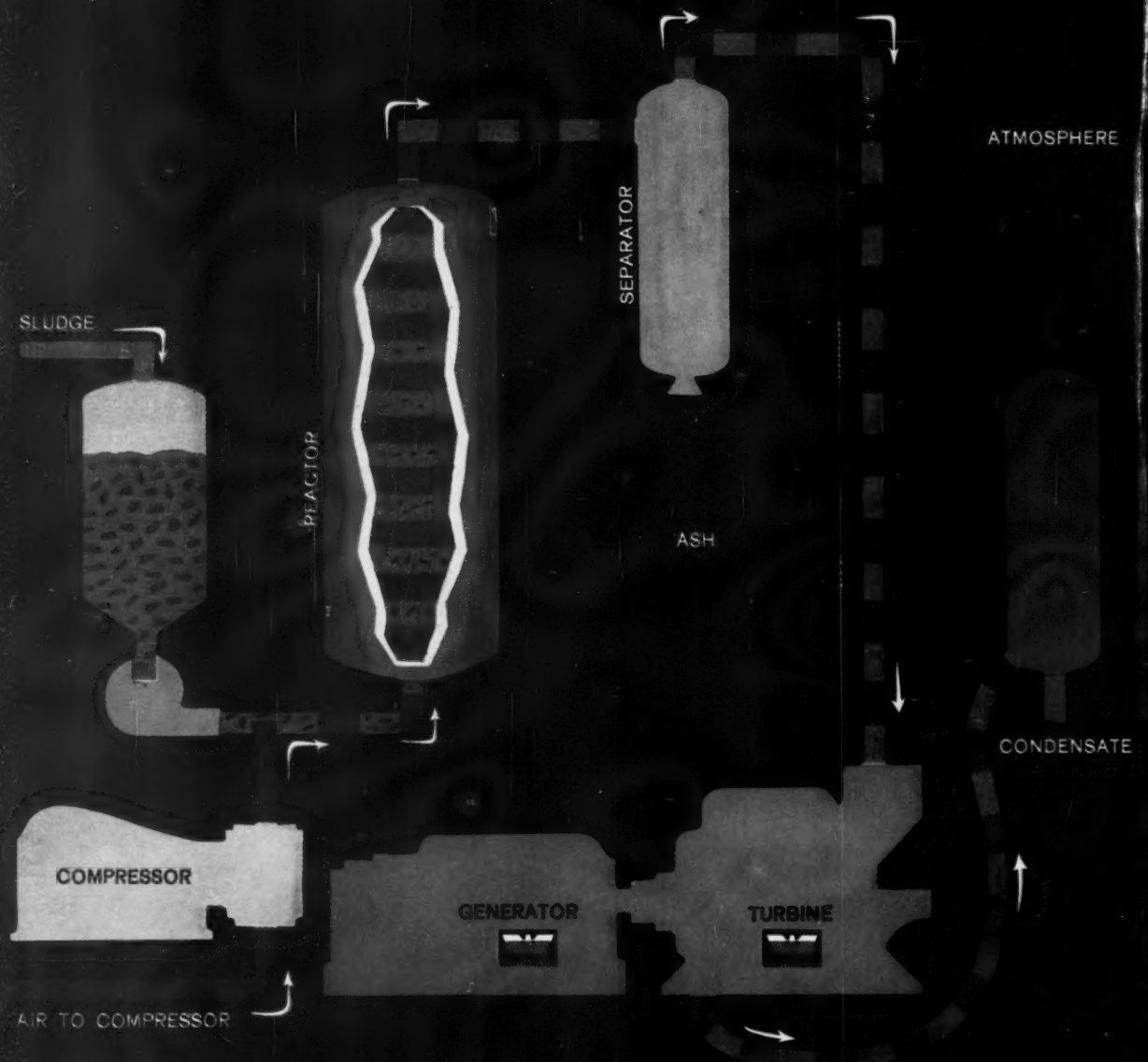

Worthington turbine generator and Zimmermann process produce...

FREE POWER FROM WASTE

Take nearly any combustible organic waste in aqueous solution. Then react it with air under high pressure. Then use the resulting gas and steam mixture to drive a Worthington power recovery turbine. With sufficient organic content you'll get enough power to run the disposal process—and in some instances a great deal more, too.

In Chicago a $12 million plant built on this Zimmermann Process* will dispose of 200 tons a day (dry basis) of sewage sludge. But the process runs equally well on many industrial organic wastes; for example, waste pulp liquor from a pulp mill and on much smaller tonnage than the large Chicago installation.

Key factor in process efficiency is the direct power recovery from gas-steam mixture produced by the reaction. In the Chicago installation, this mixture will drive a Worthington 12,500 kw. turbine generator.

Why was the Worthington turbine generator unit chosen? Because Worthington turbine specialists lead in designing turbines for power recovery from any gas mixture, including the gas-steam produced here. Because a Worthington generator has quality not exceeded by any other generator manufacturer today. And because of Worthington's reputation for extreme reliability in the industrial turbine field.

For further information about any power recovery turbine application, write or call Worthington Corporation, Turbine Division, Dept. 48-13, Wellsville, New York.

*The Zimmermann Process is patented and licensed by Sterling Drug Inc., N. Y. C., N. Y.

WORTHINGTON

PRODUCTS THAT WORK FOR YOUR PROFIT

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